

Final Report

1. The name of the Cooperator, the Project Title, the Cooperative Agreement number, date of the report, and project time period.

Name of Coordinator: Lori Hennings
Project Title: Moving Towards Adaptive Management: Validating Metro's GIS Model
Cooperative Agreement #: FWS#1448-13420-01-j141
Date of Report: July 30, 2003
Period of time covered in report: 07/30/01 through 07/30/03

2. Project description, including a comparison of expected and actual goals, accomplishments and benefits.

The project is described in more detail under Item #3. The initial grant application included a list of expected benefits for this project. The primary goal of the project was to test the hypothesis that the Wildlife Habitat and Riparian Corridors GIS models can predict habitat quality, and this goal was accomplished. Below we address each potential benefit listed in the original application and whether this benefit has been achieved.

- *Introducing a science-based field component to Metro's GIS modeling, based on ecological functions, wildlife, and habitat.* **Accomplished.** Metro systematically set up scientific surveys to test the models.
- *Assess the GIS model's performance based on statistically and ecologically valid procedures.* **Accomplished.** The Wildlife Habitat model was successfully tested in detail, and one of the original model criteria was dropped because it was not statistically important to the model. The Riparian Corridors model was more difficult to test because stream corridors form a continuous gradient, both longitudinally and laterally, resulting in a variety of model scores around a given point. However, the model is based on the extent of natural resources such as forest canopy cover to indicate stream health; the field work affirmed the importance of trees to stream health and to the GIS modeling criteria.
- *Add an adaptive management component to Metro's planning work by establishing an information feedback loop into the modeling process.* **Accomplished.** Field work identified the need for better data sources and, combined with statistical analyses, suggested removal of one model variable. Both of these needs were subsequently addressed.
- *Add credibility to Metro's planning work by introducing an on-the-ground component.* **Accomplished.**
- *Establish ecological and habitat conditions that are collected in a standardized, repeatable fashion using "hard" (on-the-ground) data.* **Accomplished.** We used field-validated survey instruments for Wildlife Habitat Assessments (WHAs) and existing DEQ protocols for collecting macroinvertebrates and calculating the B-IBI.

- *Identify potential reference watersheds for future regional, watershed-based restoration planning.* **Accomplished.** We located five reference sites that were in substantially better conditions than other sites, although generally not pristine. However, we had difficulty finding low gradient reference sites because most have been substantially disturbed.
- *Identify and delineate regionally important riparian corridors and upland habitats for future protection and restoration.* **Accomplished.** The fieldwork validated the GIS models; the GIS models identify regionally significant riparian corridors and wildlife habitat.
- *Identify and delineate habitats important for sensitive wildlife species (as identified through state and federal status) for future protection and restoration.* **Accomplished.** See previous bullet item. However, more work could always be done. Our surveys included notations on species, including sensitive species, and where they were found, as well as the habitat type and conditions in which they were located. Some of this information has already been shared with agencies or organizations (e.g., City of Portland; The Nature Conservancy; Metro's Parks and Greenspaces).
- *Identify and delineate endangered habitats (e.g. oak savannas and woodlands, wetlands, bottomland hardwood forests, native prairie grasslands) for future protection and restoration activities.* **Accomplished.** These habitat types were delineated on high-resolution aerial photographs as they were identified. The information is freely available to anyone who wants it, and availability of this data was made public at the 2003 Urban Ecosystem Research Consortium.
- *Establish baseline environmental conditions against which future changes, land use impacts, and results of management activities such as functional restoration may be compared.* **Accomplished.** The data we collected can be used to measure future changes, if desired.
- *Assess the accuracy of Metro's GIS and satellite data layers (ground-truthing).* **Accomplished.** Fieldwork identified the need for better data sources. Stream line and other corrections were noted on aerial photos, as appropriate.
- *Protect the biological, physical, and social integrity of the region's watersheds.* **Not yet accomplished,** but we are working on it. Stay tuned for more on Goal 5.
- *Share data with local jurisdictions and other interested parties.* **Accomplished.** For example, City of Portland, The Nature Conservancy, and others have requested and received the data. However, we hope more entities may find it useful.

3. Actual work tasks implemented and project timeline.

Briefly, the field studies included three components, and these are the primary work tasks, in addition to statistical analyses and production of the final report. The first component relates to the wildlife habitat inventory, and the second and third relate to the riparian corridors inventory. Analyses are now complete and are summarized below (wildlife habitat) and in Section 10 (riparian corridors).

a) ***Wildlife Habitat Assessments (WHAs):*** Metro revised an existing methodology (WHA; see Section 10) based on extensive input from U.S. Fish and Wildlife Service, Oregon Department of Fish and Wildlife, and the City of Portland (who has extensively used a previous version of the methodology). This assessment relies on a team of biologists walking through a site, discussing its characteristics and scoring it based on the quality of water resources,

vegetation (wildlife cover, food, native vs. nonnative plants, and structural complexity), and human influences. The revised method was successfully field-checked against quantitative data collected at 54 study sites in 1999 (Figure 1; Hennings 2001, Hennings and Edge 2003). It was then performed on 102 additional randomly selected natural areas to test the Wildlife Habitat model (Figure 2). Results for this part of the study are presented in the next section, entitled "Results of Wildlife Habitat Assessments."

Results of WHAs. To test the substantially revised WHA protocol (protocol and datasheet attached), the field crew first assessed 54 study sites for which we had quantitative plant data from 1999 (Hennings 2001; Hennings and Edge 2003). This quantitative data, including structural complexity and the relative amounts of native versus nonnative plants, was distilled into a "megavariable," or a cluster of variables that were statistically related both to one another and to bird communities. The statistical method used was Principal Components Analysis, or PCA. As scores for the megavariable (PC1 in Figure 1) increased, bird diversity and species richness increased, while the percentage of nonnative birds decreased. The protocol worked very well, based on linear regression of WHA scores against 1999 field-based scores (Figures 1 and 2). Thus, the WHA is an appropriate technique to measure the effectiveness of the GIS model in identifying habitat patches important to birds and presumably, other wildlife.

After the methodology was successfully tested, we conducted habitat assessments on 102 randomly selected habitat patches. To obtain a relatively even sample spread across the range of possible model scores, we first divided the universe of wildlife habitat patches into five equal scoring classes. We then randomly selected similar numbers of patches from each scoring class (but note that the highest two classes contained too few patches for a full suite of samples). A predetermined criterion for inclusion in the selection pool was that some part of each patch must include or be adjacent to public lands of some sort, so that field crews would have the ability to access the patch. Field crews also routinely asked for and received permission from landowners to enter the patch.

We statistically assessed (a) WHA scores versus each individual model criterion, and (b) WHA scores versus the model's overall performance. We examined scatterplots and conducted correlation analyses, simple linear regression (for individual variables) and multiple linear regression (for appropriate variable combinations) to determine the significance of each criterion in the GIS model. Except for the species richness criterion, all model variables showed a relatively strong ($r^2 \geq 0.50$), statistically significant relationship ($P < 0.0001$) with field-based scores. The ONHP species richness criterion was statistically unrelated to field-based scores ($P > 0.1$), possibly due to the large spatial scale at which this data was mapped or due to non-comprehensive survey data. The ONHP species richness model is currently being refined, and may well prove useful in the future. Mallow's cP statistic (a variable selection technique) suggested that the most appropriate model included four criteria: habitat patch size, interior habitat, connectivity to other patches, and water resources (Figure 1). The results of these analyses provided input into model refinement.

Field studies also revealed that some habitat patches were poorly defined due to the relatively large (24 m) raster size inherent in the satellite data used in the original model. In such cases we did not conduct WHAs but moved on to the next randomly selected habitat patch that was

accurately delineated. However, this revealed the necessity to more accurately define patches based on hand-digitized forest canopy and low-structure vegetation, and the subsequent model version reflected this change.

Figure 1. Wildlife Habitat Assessment validation: WHA score vs. 1999 PC1 score (a composite variable in which high-scoring sites were wider, more structurally complex, and more native).

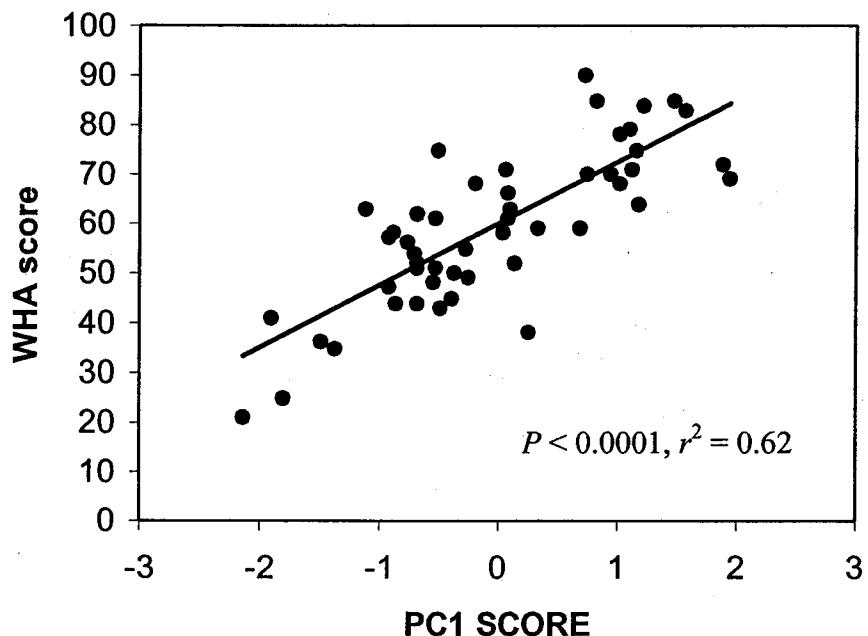
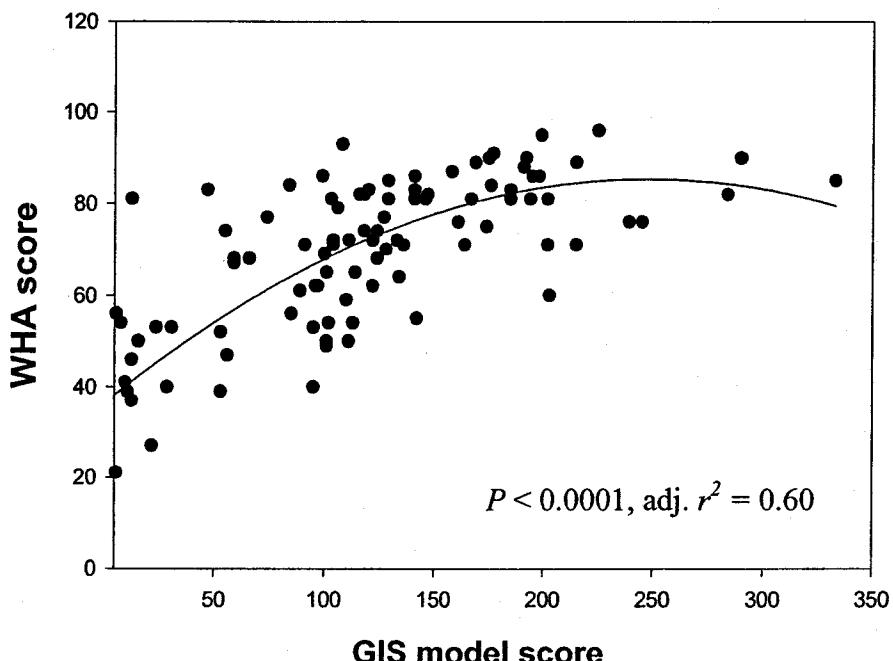


Figure 2. Wildlife Habitat Assessment (WHA) field-based scores versus revised GIS Wildlife Habitat Model scores (based on size, interior habitat, proximity to other patches, and water resources).



b) Rapid Stream Assessment Technique (RSAT): Metro modified an existing qualitative methodology with help from other experts (e.g., Clean Water Services and Michael Cole of ABR; data sheet attached). This procedure also relies on a biological team to measure parameters such as stream bank erosion, sedimentation within the channel, and channel substrate composition. It focuses on capturing the characteristics important to macroinvertebrates and the deleterious effects associated with urbanization. RSATs were conducted at all macroinvertebrate sampling sites (described next); relationships between RSAT variables will be statistically related to the scores to test for correlations with GIS model scores, similar to the statistical analyses employed to check the Wildlife Habitat model. We will also examine relationships between instream conditions and macroinvertebrate communities (see item 3).

c) Benthic Index of Biological Integrity (B-IBI): Macroinvertebrates are useful indicators of instream conditions because different types of macroinvertebrates respond differently to a variety of environmental parameters (e.g. sedimentation, stream temperatures, dissolved oxygen, etc.). Thus what is in the stream, and what is missing, reveals information about stream habitat conditions. We sampled invertebrates at 54 sites in the Metro region based on Oregon Department of Environmental Quality's current methodologies; the samples were analyzed and the majority of statistics were performed by Dr. Judith Li's invertebrate lab at Oregon State University. The results are in Section 10.

Results of RSATs and B-IBI (see also Section 10). Most of our sites received low quality B-IBI scores, based on the protocols devised by Rick Hafele at the Oregon Department of Environmental Quality (Hafele 2001). This probably reflects the cumulative impacts associated with relatively high existing levels of urbanization; Clean Water Services' consultant showed similar findings in Bannister and Bronson Creeks, using Karr's B-IBI protocols (Aquatic Biology Associates, Inc., 1998).

Apparently, a finer level of distinguishing between sites is needed for the Portland metro region, where many streams have already undergone substantial alteration and degradation but where there are likely quality differences, within the lower range, between sites. We approached this dilemma in two ways. First, we re-analyzed the macroinvertebrate data based on a B-IBI protocol devised specifically for urbanized streams in the Puget Sound Lowlands ecoregion, to determine whether it provides a better tool for distinguishing between sites. B-IBIs are a *multimetric* approach resulting in qualitative scoring.

Second, we conducted *multivariate* analyses, as well as comparing statistics between impaired, intermediate and reference sites, to assess relationships between environmental variables and macroinvertebrate taxa. Multivariate analyses are more complicated than multimetric analyses, but sometimes yield more meaningful results for complex datasets such as ours. Environmental variables for our multivariate analyses included onsite in-stream and near-stream data from RSATs, as well as GIS data including drainage area, street density, channel type, prevalent landcover type and land use. When feasible, Metro gathered GIS data following May et al.'s (1997) suite of riparian habitat quality indices for Puget Sound Lowland streams for this portion of the analyses.

Time line. As scheduled, in summer and fall 2001 we conducted surveys. In fall/winter 2001 we analyzed the WHA data, used the results for adaptive management in the natural resources modeling process, and began a contractual arrangement with OSU to analyze the macroinvertebrate data. A new contract with OSU was initiated in August 2002 to finish the statistical analyses, and these analyses are now complete. The final report took longer than we anticipated, but it is complete and attached in Section 10.

4. List of project staff and partners, and their roles. Also include the number of volunteers and other participants involved, along with the number of hours contributed to the project.

Lori Hennings was the primary contributor to this project (see Budget Summary table). In addition, Jeff Lerner (now an Intern at Metro) provided approximately 60 hours valuable volunteer work by entering all field data during Summer 2002. Other partners included USGS and DEQ (loaned sampling equipment and provided expertise).

5. Description of the project area and/or study location. Include dimensions of the actual area affected and/or studied, a map showing the location of project activities, and final project designs, plans and as-built surveys, as applicable.

Please see study sites map in Section 10 for the macroinvertebrate study sites. The Wildlife Habitat Assessments were conducted throughout the region, thus no map is available for that part of the study.

6. A description of the methods used to implement the project and the effectiveness of those methods.

The methods used for this project are in Section 10. We tailored the methods to our needs and had no difficulties using them; the field methods and variety of statistical analyses used appeared to be effective in meeting our needs.

7. On-going tasks that will continue beyond the term of the agreement, such as monitoring and maintenance.

No ongoing work is planned for this project other than data sharing and the potential for publication.

8. Summary of expenditures and project costs, including the use of FWS funding and the amounts and sources of monetary and in-kind matching contributions. Include an accounting for any real and personal property acquired with Federal funds or received from the Federal Government

according to requirements of regulations referenced in "APPLICABLE REGULATIONS" section of this agreement.

No real property was acquired through this project; all field-sampling equipment was borrowed.

As of the date of this report, we have expended \$38,079 of the total grant money, with \$437 remaining. It is our understanding that the remaining funding will be rolled into the 2003 award. Most of the funds have gone towards personnel costs, for the 3-person field crew hired last summer/fall and the Oregon State University macroinvertebrate consultant, who analyzed the samples, conducted statistical analyses and produced the final report. Metro's Data Resources Center (DRC) conducted GIS work for this project but failed to code their time to the grant; therefore, no GIS matching funds are shown, although they were provided. In addition, Metro paid for an extensive set of vaccinations for the field crew to protect their health, and that is not reflected in the matching funds.

The actual budget deviated somewhat from the estimated budget, as noted in last year's annual report. The table below represents the final expenditure outlay for the entire project.

Expenditure type	USFWS	Matching funds
Salary (field crew and OSU laboratory)	\$26,224	\$53,320 (match includes fringe benefits, leave, and overhead for Lori Hennings) Volunteer time – Jeff Lerner; approximately 60 hours @ \$16/hour = \$960
Materials and supplies (includes field vehicles)	\$11,855	
Remaining funds	\$437	
TOTAL	\$38,516	\$54,280

9. Summary and conclusions. Include any advice from this project experience that may assist others involved in similar work.

To date Metro has reviewed the scientific literature pertaining to wildlife and habitats in urban ecosystems, created a corresponding model rating existing habitats in the region, and in a USFWS-funded step adding significant scientific credibility to our approach, field-tested the model to assess its validity. We have adjusted the model to reflect our findings (adaptive management); the revised GIS wildlife habitat model is ecologically valid based on local field data. The success of the revised model scores in predicting "better" habitats – that is, the good structural complexity, higher percentage of native plants, and good food and water resources associated with enriched native bird communities – allowed us to confidently proceed with inventorying the region's wildlife habitats. It provided important information concerning quantity and location of wildlife habitat patches and allowed us to differentiate sites based on habitat quality. The data is available to anyone who needs it.

The USFWS funds have been used to provide the following tangible products:

- Field-validated wildlife habitat assessment methodology specific to urban areas (three other jurisdictions have already asked for and received the revised protocols)
- Cumulative site-specific data adding to existing information on the original 1999 study sites (54 sites; 1999 bird data, now layered with Wildlife Habitat Assessments, RSAT and macroinvertebrate data); potentially valuable for long-term study objectives
- New baseline WHA data for 102 wildlife habitat patches
- Numerous sensitive species sightings from these surveys were incorporated into Metro's Species of Concern data layer
- Baseline data for the GIS-modeled regional system of wildlife habitats and riparian corridors
- Greatly enhanced scientific credibility for Metro's inventory process

We are grateful to the USFWS for the timely, critically important support in this regional inventory of wildlife habitats and riparian corridors, and believe it to be a good investment in the future "nature of the region."

The key findings are as follow:

- Without the Species Richness criterion, the Wildlife Habitat GIS model performs well. That criterion was dropped and all others retained. The attributes of patch size, connectivity to water, connectivity to other patches, and patch shape were all important.
- The fieldwork generally validated the Riparian Corridors model in that existing forest canopy both near the stream and further away appear to contribute to stream health.
- An urban threshold was apparent, beyond which stream health is degraded. Most of the streams sampled were in degraded condition.
- Intermediate stream sites were located in which conditions were better than impaired sites. The key variables differentiating reference from other sites was road density and forest canopy cover; the key variable differentiating intermediate from impaired streams was forest canopy cover.

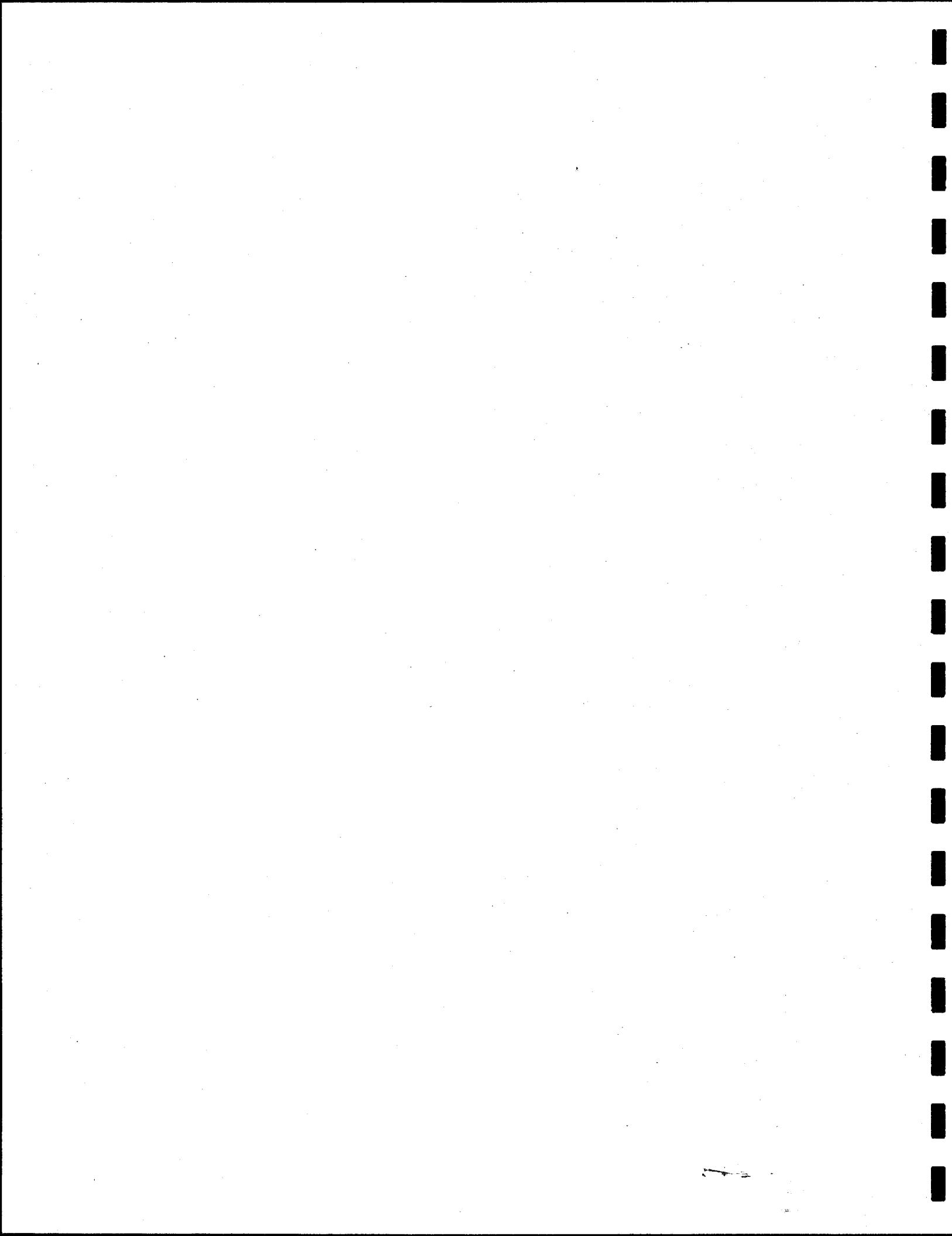
10. Supplemental information such as copies of data collected, documents, scientific papers, printed materials, or other products related to the project. A set of color slides/prints with descriptions must accompany the report to depict project activities and, for habitat restoration and/or enhancement work, site conditions before, during, and after project implementation.

List of documents appended:

- Wildlife Habitat Assessment (WHA) methodology and data form
- Rapid Stream Assessment Technique (RSAT) data form
- Benthic invertebrate report, including study sites map (Frady et al. 2003)

Literature Cited

- Aquatic Biology Associates, Inc. 1998. Unified Sewerage Agency, Hillsboro, Oregon: Benthic invertebrate biomonitoring for Bannister & Bronson Creeks, 1995-1998. Prepared for Unified Sewerage Agency (new agency name: Clean Water Services), Hillsboro, Oregon.
- Hafele, R. 2001. Stream macroinvertebrate protocol. Chapter 12 in: Oregon Plan for Salmon and Watersheds Water Quality Monitoring Guidebook. Version 2.0, various authors. Available online at [<http://www.oregon-plan.org/cdrom/monguide2001.pdf>].
- Hennings, L.A. 2001. Riparian bird communities in Portland, Oregon: Habitat, urbanization, and spatial scale patterns. Masters' Thesis, Oregon State University Department of Fisheries and Wildlife, Corvallis, Oregon.
- Hennings, L.A. and W.D. Edge. 2003. Riparian bird community structure in Portland, Oregon: habitat, urbanization, and spatial scale patterns. *The Condor* 105:288-302.
- May, C.W., E.B. Welch, R.R. Horner, J.R. Karr and B.W. Mar. 1997. Quality indices for urbanization effects in Puget Sound lowland streams. Washington Dept. of Ecology, Water Resources Series Technical Report No. 154.



METRO 2001

WILDLIFE HABITAT ASSESSMENT METHODOLOGY

The following Wildlife Habitat Assessment (WHA) data collection and numerical rating system is a modification of one that was originally developed for site-specific use in the City of Beaverton in 1983 as part of their statewide planning Goal 5 update (we define a "site" as a contiguous habitat patch surrounded by other land use types). The original methodology was designed by a technical advisory team consisting of staff from the City of Beaverton, Portland Audubon Society, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, Oregon Department of Fish and Wildlife, and the Wetlands Conservancy. Since that time, it has been used in Washington County, Gresham and in the entire Portland metropolitan region, including the Willamette Greenway, as well as Eugene and other areas statewide. Selecting a widely used protocol is advantageous because it potentially allows for comparison and repeatability of data over space and time. The methodology in its current form was modified based on input from Jennifer Thompson (U.S. Fish and Wildlife Service), Holly Michael (Oregon Department of Fish and Wildlife), and Tom McGuire (formerly City of Portland, currently with Adolfson and Associates) and Barb Grover (City of Portland). We thank them for their technical assistance.

Each time this methodology has been used, it has been slightly modified and refined to address the specific needs of local jurisdictions and the Oregon Department of Land, Conservation, and Development (DLCD). For example, Metro has added data columns for the presence of downed wood and nonnative plants, two major urban habitat issues; in addition, we have altered the Water Quality category to reflect channel and bank morphology and stability rather than basing it on water quality, which we are currently not equipped to measure in the field. In addition, Metro did not use three categories from the score sheet: flora, uniqueness of habitat type, and interspersion. We recorded relevant information but omitted scores from the first two categories because we were using the inventory to test our GIS model, which did not consider specific habitat types. We did not score or use interspersion because small-scale habitat juxtapositions are not always advantageous for urban wildlife, as such interspersion often points to habitat fragmentation and deleterious edge effects.

The WHA is inherently biased towards vegetative types with woody structure. This is one of the drawbacks of using a generalized methodology for assessing multiple habitat types – habitats that are potentially of great importance, such as native grasslands and oak savannas, may receive low ratings due to natural lack of structural diversity. Yet many habitat specialists rely on these habitats. For this reason, Metro emphasizes the importance of delineating such rare, important habitats in a separate step during the planning process, rather than relying solely on a generalized methodology such as the WHA (unless all potential habitat patches are equally assessed). The WHA is one tool among many that should be utilized in thoughtful wildlife habitat planning.

The following is a discussion of that methodology as it was applied by Metro in the Portland metropolitan region. The methodology involves identifying and evaluating parameters that make sites good or potentially good wildlife habitat areas. There are two parts to the methodology:

1. A narrative description of the site.
2. A numerical rating of various wildlife habitat parameters.

NARRATIVE DESCRIPTION

A narrative description of the site and survey conditions, including weather, topography, vegetation, wildlife habitat features, human use and habitat enhancement potential, are completed at each site using a standard inventory form (see attached form called *Wildlife Habitat Assessment Narrative Sheet*).

NUMERICAL RATING

The numerical rating system (see attached form called *Wildlife Habitat Assessment Scoring Sheet*) reviews each site in terms of its potential for wildlife. The system is based on the fact that all wildlife has three basic requirements for survival: food, water and cover.

Each site is to be evaluated in terms of relative quantity, quality, diversity and seasonality of the components that appear at the site. Also considered are human disturbance, the proximity to other aquatic and upland areas, unique or rare features, and wildlife, flora and habitat types. Note that the "Score Existing" and "Score Enhanced" refer to existing conditions versus the site's potential if successful restoration efforts were implemented; these potential restoration activities should be documented in the narrative description under "Restoration Potential."

This rating system was meant to assess the relative values of aquatic and upland habitats. It was not intended to provide a comprehensive analysis of each site. Information derived from the rating sheets should be used in tandem with the narrative descriptions. However, if performed during the same year by the same well-trained field crew, the WHA scoring methodology allows for general comparisons of wildlife habitat quality between a wide variety of habitat types. This consideration and time required in the field are the primary advantages of using a qualitative methodology such as the WHA over a quantitative one.

DESCRIPTION OF VARIABLES

- Photos** List photo roll and exposure numbers, or whether digital camera was used (if digital camera used, first photo should identify site so as not to confuse exposures). If no photos are taken, state so.
- Site ID** A space is provided for the observer to label each site with an individual identification number or code. These codes will be predetermined.
- Site Name** Name of park(s), property owner, or address of site.
- Thomas Guide** Map page and grid number so anyone can find their way to the site.
- Directions** Directions to the site and entry point. Give directions from nearest major road. Indicate the boundaries of the extent of the site surveyed (you may mark this on the map if preferred).

The table on the Scoring Sheet consists of 20 components that are evaluated for each site. The 20 components are divided into six general categories:

1. Water
2. Food
3. Cover
4. Human disturbance
5. Unique features
6. Important habitat features

Consistency of scoring can only be accomplished through extensive group training at the same sites, in combination with periodic "calibration" sessions in which the group reassembles and ensures that scoring is consistent among individuals. In most cases, scoring should be based on the degree to which the site is in a natural vs. unnatural/disturbed condition and to account for variety of native habitat types and natural conditions.

Note that any whole number within the point range for each category may be used; for example, if the range of choices is 0, 4 or 8, an observer could assign any whole number between 0 and 8. This will help prevent the observer from having to make arbitrary judgment calls if a criterion appears to fall between categories.

WATER

Four aspects of water characteristics on a site are included on the rating form: seasonality and quantity; channel morphology, complexity and alteration; proximity to cover; and diversity (e.g. ephemeral and perennial streams, ponds and wetlands). All of these factors play an important role in the site's significance to wildlife.

It is important to note that the relative value of these aspects compared to most other components (food, cover, human disturbance and unique features) was higher. The reason for this weighting of the relative value of the water component was that wetlands and riparian habitats are disproportionately important to wildlife. Therefore, it is possible that a site with good water resources but lesser values under other categories would rank higher than an upland site with better food and cover values.

Seasonality and quantity: This aspect refers to the amount of water available on site and its seasonality. Year-round water is extremely important to most wildlife species, particularly in an urban setting where habitat fragmentation may isolate habitat patches from other water sources. For example, this could include a perennial stream where there is evidence of associated ephemeral (seasonal) wetlands (indicated by vegetation) and/or dry side channels (indicating presence of ephemeral streams). Ephemeral streams and wetlands provide important habitat to fish and amphibians that is different from perennial sources. A site with a perennial stream but no evidence of other water sources such as those described above should receive a score of 6 or 7, weighted by the size of the stream and its relative importance to the patch. For example, if the habitat patch is very large but only has one small stream present, certain non-mobile groups such as amphibians would have a hard time getting to the stream from the outer edges of the patch, thus this site would receive a 6 instead of 7. A site with only seasonal or ephemeral sources would receive a 4. A site without any apparent water resources should receive a zero in this category.

Channel morphology, complexity, and alteration: Metro changed this criterion (formerly "quality") because we did not feel that stagnant or seasonally flushed water could accurately reflect water quality without more technical measurements. Furthermore, we were unlikely to be able to ascertain the flushing frequency of such water sources. Thus we selected a criterion that is particularly important to instream and other aquatic habitat because it reflects alterations in the hydrologic regime. However, we have weighted this criterion somewhat lower than the other three aquatic criteria because the simple presence of water is critically important to so many terrestrial species, and the WHA is generally geared towards terrestrial wildlife habitat.

Streams with altered hydrologic regimes are unable to support the same quantity and quality of instream wildlife. For example, urban streams often become "flashy" – that is, during a storm event water levels both rise and drop more quickly than in undisturbed conditions. This causes bank erosion and other effects, changing the channel form and composition of the substrate. One result is that aquatic invertebrate communities are typically simplified, presumably resulting in reduced food resources for both instream (fish and aquatic amphibians) and terrestrial vertebrates (birds, some small mammals, and terrestrial amphibians). Water quality is also typically lower in these sites due to sedimentation and toxins that enter the stream from impervious surfaces and storm drains. High-scoring sites should show little evidence of degradation; signs of stream degradation include channel incision and containment (i.e., not allowed to meander), evidence of erosion (rootlets, undercutting, toppling woody vegetation, bare soil) along the banks, and heavy sedimentation within the streambed. Other factors, such as oil sheen, sewerage smell, pipes and culverts, or excessive trash in and near the stream, may also downgrade this criterion. Healthy streams should contain a good supply of large wood.

Ponds and wetlands may also show evidence of human-induced alterations. For example, some constructed wetlands may not perform functions adequately imitating those found in natural wetlands, and some human-made ponds may be armored, dammed or otherwise altered. Levees and dikes are another form of modification. Some wetlands may appear to have been drained and/or filled. Such water resources are probably not as valuable to wildlife as "natural" ponds and wetlands, and should receive a somewhat lower score under this criterion. Other factors similar to those mentioned above (e.g., unstable banks, oil sheen, etc.) also generally apply to these water sources.

Proximity to cover: Wildlife will use water more if it is close to vegetative cover. This allows escape from predators and protection from weather extremes. The closer and more dense the cover, the more important the water source to many species. Dense cover immediately adjacent to a water source gave the site a value of 8, nearby cover a value of 4, and no cover a value of 0.

Diversity: A site with a mixture of wetland, stream and open pond or lake has higher wildlife value than a site with only one of these features. Lowest scores have no water present at the site (score = 0); sites with only one water source receive 4 points; sites with > 1 water source (two different types of streams [ephemeral and perennial], a stream and a pond, pond and wetland, etc.) receive a score of 8. Sites receiving the highest scores should have more than one type of water available, with at least one perennial (available year-round) source.

FOOD

Food is a basic requirement for any organism. Wildlife species cannot survive in one area for any appreciable period of time without food. The greater the variety and quantity of food, the greater the potential for serving the needs of more wildlife species. The three aspects included under food are variety, quantity, and seasonality. Metro altered these criteria slightly (formerly variety, quantity and seasonality, and proximity to cover) because most food resources *are* cover.

Variety: The variety of food on a site was rated from 8 (high) to 0 (low). We recognize that any intact food web includes plant matter, insects, and other animals; however, we focus here on plants because that is what can be readily assessed using this methodology. The presence of insects and other wildlife depends largely on water and plant resources, thus non-plant food resources are covered to some degree under other categories. A site with little or no "food plant" species – for example, a site dominated by reed canarygrass or Scot's broom – receives a score of zero, whereas a site with limited food such as one dominated by Himalayan blackberry receives a score of 2-4 (depending on whether it is a native species, which would score higher), and a site with several food species may receive a score of 4-8. Native flowering plants are also a food source, but should not count into the scoring as much as fruits, nuts and berries.

Quantity: This aspect measures the amount of food and its availability. Sites having large quantities of food available received a value of 8, and sites with little or no food available received a value of 0. To receive the maximum score, food plants should be primarily native. For example, sites limited primarily to blackberry patches could receive a score of 2, whereas similar quantities of a native source would receive a 3. Keep in mind the 3-dimensional nature of food availability.

Seasonality: This aspect measures the year-round availability of food. Sites which provide food year-round received a value of 8, and those sites providing limited food seasonally received a value of 4. Sites with food available in only one season received a score of 2. This has to do with the timing of fruiting or seed setting. For example, spring plants include Indian plum, salmonberry, ferns, fungi, and flowering plants (including maples). Summer plants include red-osier dogwood, salmonberry, thimbleberry, strawberry, Oregon ash, red alder, blackberries and cherries. Fall plants include salal, Oregon grape, hawthorn, rose hips, ocean spray, Douglas' spirea, blackberries, Oregon ash, red alder and oaks. Wintertime food sources might include hazelnut and other nuts, oak, snowberry, and conifers; highest scoring sites should include such food resources.

COVER

The aspects of cover included here (structural diversity, variety and seasonality, and nesting and denning sites) attempt to describe the physical environment of the site from a number of perspectives that are important to wildlife.

Structural Diversity: What is looked for in this category is the vertical stratification of the vegetation on a site. That is, is there only one layer of vegetative cover (e.g., lawn or one layer of shrub, such as Himalayan blackberry) or are there two, three or more layers. The most diverse structural system in our area would be multi-layered, with a ground layer of herbaceous vegetation (sedges, grasses, ferns, herbaceous plants, etc.), a second layer consisting of shrubs (Himalayan blackberry, snowberry, Oregon grape, etc.), perhaps another layer of taller shrubs (red or blue elderberry, Indian plum, red osier dogwood, vine-maple, ninebark), a short tree layer (Pacific or red-osier dogwood, hazelnut, saplings of taller species), and finally the tall canopy layer (Douglas-fir, Western hemlock, big-leaf maple, black cottonwood, Oregon ash, Oregon white oak, etc.). The highest scoring sites should have a range of age and size classes. The more layers present, the greater the surface area for feeding, traveling and breeding available to a wider diversity of wildlife species. In general, woody vegetation (tree and shrub cover) are more important than herbaceous cover in the types of habitat we are surveying. However, certain plants such as sword fern also provide invaluable cover to low-dwelling creatures. Values range from 8 for high structural diversity to 0 for low or no structural diversity.

Variety and seasonality: This reflects the variety and year-round availability of plants within each vegetative layer. Variety of cover is important from cover, feeding and reproductive standpoints. The greater the variety of cover, and the longer it is available to wildlife through the year (e.g., conifers and sword ferns provide better winter cover), the more important the habitat. For example, a forested wetland with a mixture of rushes, sedges, spirea and willows will be a much more important wildlife habitat area than a wetland with a monoculture of reed canary-grass. Variety values range from 8 for high variety to 0 for no or low variety. Reed canarygrass monocultures should receive a 1, mowed lawns a 0.

Nesting and denning sites: This criterion refers to structures such as snags, cavities, stumps, large downed wood, vegetative cover, clumps of mistletoe, large trees, logs, undercut banks, brush piles, root wads, bird and bat boxes, old unused buildings, and reptile/amphibian hibernacula such as rocky outcrops and rock piles. Sites with a variety of nesting and denning sites may receive up to four points.

The third part of the form includes values in addition to food, water and cover. The components examined include human disturbance, unique features and important habitat features.

HUMAN DISTURBANCE

Disturbance is examined from two perspectives – modifications to the physical habitat and actual on- or near-site audible or visible disturbances. The previous (non-Metro) version dealt more with natural disturbances; while we recognize that natural disturbances are very important agents of influence on wildlife communities, the natural disturbance regime in urban areas (e.g. fire, landslides, flooding) is often suppressed or highly modified by human activities. In addition, it is a judgment call as to whether such natural disturbances are beneficial or detrimental to wildlife. Thus Metro altered these criteria to clarify their meaning and reflect more human-related disturbances, and also increased their range of values to reflect the importance of human disturbance to wildlife and habitat in the urban setting. When scoring these and other criteria, keep in mind the extent of disturbance relative to habitat patch size.

Habitat modification, structures, etc: This category was used to assign a higher value to those sites with little physical modification and to reflect the fact that the removal or disturbance of physical components (food, water, cover) is detrimental to wildlife. The presence of structures, human trails, roads and paved areas, houses, playgrounds, sewer and stormwater manholes, outfalls or pipes, homeless camps, trash piles, etc. alter natural habitat. Significantly modified habitats such as lawns also fall within this category. Houses and buildings intrude light into habitats at night and are also usually sources of further disturbances. Some species seem to be human-avoiders; for example, larger habitat patches with no roads,

trails, etc. in the patch's interior may provide very important "interior habitat" for some disturbance-sensitive species such as Neotropical migratory songbirds. In general, the more physical alterations to a habitat patch, the more altered the wildlife community is likely to become. For example, a moderately wide habitat patch (75-100 m) with some lawn and houses adjacent to the patch but some ($\geq 25\%$) intact natural forest and/or other natural habitats, might receive a 4. A large patch with a major trail or several minor trails, but little other disturbance, would receive a 5 or 6, whereas a smaller patch with the same amount of trails and disturbance might receive from 2-4, depending on the amount of disturbance relative to the habitat patch size.

Direct human disturbance (people on trails and elsewhere, voices, road noise, pets, etc): Even if an area is highly disturbed from a physical perspective, it may receive little human use. Human and human-related (domestic animal) disturbances can be very detrimental to wildlife. This criterion deals specifically with humans (on foot or in vehicles) and their pets, and refers to human-associated disturbances that can be directly seen, heard, or otherwise detected. Examples include road noise, voices, music, construction and industrial noise, lawnmowers, dogs barking, or humans, dogs or cats seen. It is recognized that time and date will influence this criterion; for example, a park visited on the weekend or after school hours may have more humans and pets around. However, that is something we cannot address here without more time and money, thus we can only estimate these influences based on what we see and hear. To compensate for this flaw we assigned a somewhat lower range of scores for this criterion (0-6 rather than 0-8 for the Physical Disturbance category). A site with multiple human (or pet) related disturbances such as road noise, barking, presence of or sounds from humans (voices, chainsaws, music, etc.) receives a low score, whereas a site where none of these influences are heard or seen receives a 6.

WILDLIFE

Because this is a qualitative rather than quantitative survey method, there are some problems with this criterion, such as: differences in observer expertise, differences in wildlife detectability due to weather, changes in wildlife communities over seasons, and non-standardized amounts of time spent at various sites. As a result, Metro does not at this time intend to use the resulting criterion score in the final analysis phase. However, we would still like your professional opinion of each site's score.

Note that Metro has altered this component, which previously relied specifically on the presence of so-called "sensitive species" (those that are identified through an at-risk categorization in state or federal lists). If sensitive species were used, then sites with none detected but with very good habitat would be effectively downgraded, and that is not our intent here. In addition, in-depth searches would need to be conducted in order to locate and identify any of the large number of sensitive species that could be found in the urban region, and that is beyond the scope of this project. Another means of estimating sensitive species presence is to use the Oregon Natural Heritage Program (ONHP) data, but that is too coarse-grained for our use at this time. However, scores based on ONHP data (as well as any sensitive species actually detected onsite) could be added in the office at a later date as the data improves. Thus Metro has altered this score to more reflect wildlife diversity, and relative rarity *in the urban region*. Metro also moved two subcategories, flora and unique habitat types, to the narrative description, because (1) we are not scoring these subcategories and (2) a better written description of unique and valuable features can be made.

Wildlife: Many sites in the urban region will not receive the highest possible score in this category, reflecting the general depletion of certain large mammals and loss of habitat specialists, as well as habitat loss and alteration. For wildlife, the highest-scoring sites might have large mammals such as elk, bear, cougar, bobcat, etc. present, and this is likely only in sites such as Forest Park or perhaps Oxbow (and would be hard to document with our level of effort). Alternatively, a site with a diverse array of native wildlife species such as beaver, muskrat, otter, Neotropical migratory songbirds, and other species may receive the highest score. The presence or signs of presence of any "Sensitive Species" (see Metro's species list) would automatically bump a site up to the highest score in this category. Bald Eagles provide one example.

Known habitat specialists or animals that are relatively rare in the urban region, such as presence or sign of Pileated or Hairy Woodpeckers, oak specialists such as White-breasted Nuthatch, Acorn Woodpeckers, Western gray squirrel (also a sensitive species), unusual reptiles, mammals or amphibians, or what appears to be a very good mix of native wildlife species could increase the score in this category up to the maximum even if no sensitive species were found to be present. If only common wildlife were apparent except for Pileated Woodpecker sign, the site should receive a 1 or 2. A site with high abundance of nonnative species such as European Starlings but few other species beyond the commonplace should receive a 0. Presence of a heron rookery would increase a site's score to 4 because of its importance to a large number of water-dependent birds. Bats are of particular interest in the urban setting, thus bridges and structures should be quickly checked for crevices $\geq \frac{1}{2}$ ".

IMPORTANT HABITAT FEATURES

Interspersion with other habitats: Habitats are important to one another in the sense that a number of different habitat types and habitat patches adjacent to one another can provide an overall diversity of vegetative cover, food, and often water, as well as the potential for wildlife to move between patches. Therefore, an isolated site surrounded by pavement, buildings, bare ground, etc. would receive a lower interspersion value than if the site were surrounded by other habitat types, such as wetlands (emergent, forested, shrub), upland forests, shrubby areas or meadows. Sites receiving the highest scores would have other habitat patches nearby, and some of those habitat patches would be different habitat types than the site. The interspersion ranges from 6 for high interspersion to 0 for low interspersion.

Downed wood, old stumps and snags: The scientific literature indicates that downed wood is a fundamentally important habitat element for terrestrial insects, amphibians and small mammals. Downed wood also provides critical refugia for instream wildlife (addressed in "Channel morphology"), and ultimately derives from terrestrial sources. Snags are included here because they are future sources of downed wood, therefore indicate the continued presence of downed wood over time. Although there is some overlap with the "Nesting and denning sites" category within Cover, the importance of large downed wood justifies snag inclusion here. Sites with little or no downed wood, old stumps or snags receive a score of 0, sites with a moderate amount of such features receive a 4, and sites with relatively high amounts of woody sources receive an 8.

Percent nonnative plants: Nonnative insects, birds and other animals are generally associated with nonnative plants, whereas native animals generally prefer native plants. Nonnative organisms are a major threat to biological diversity, particularly in urban ecosystems. Edge habitats tend to contain more nonnative plants than interior habitats, thus it is important to mentally average the overall percent nonnative cover across edge and interior habitats. Nonnative plants could also have been included in the Habitat Modification criterion under Human Disturbance; we chose to place nonnatives under Important Habitat Features because they have the potential to influence several other categories (e.g., food, cover, unique features).

We have assigned different scores to each vegetation layer, recognizing that all layers are important, but some more so than others. The herb layer, with short generation times, is usually the first to "go nonnative," and is not as important to wildlife in general as the shrub layer. The shrub and canopy layers provide critical nesting habitat, cover, and food to native insects, birds and other wildlife in our region, thus these two layers are assigned greater potential point values than the herb layer. For each layer, the lowest score reflects a strong nonnative component (e.g., $\geq 25\%$ overall nonnative), whereas the highest score reflects primarily native plant cover (e.g., $>95\%$ natives).

TOTAL SCORE

This can be done in the office. Each site received a total score by adding up the points on the WHA Scoring Sheet.

WILDLIFE HABITAT ASSESSMENT NARRATIVE SHEET

Portland Metro Region

Observer Name(s): _____ Date and time: _____

Site ID: _____

Site Name: _____

1. Weather

Wind: _____ Precipitation: None Mist Lt rain Med rain Hard rain Other Snow
 Percent cloud cover: 0% 33% 66% 100% Temperature: _____

2. Physical parameters

Site dimensions and acreage (calculate using GIS; attach map for each site):

General topography (flat, rolling, ravine, bluff, etc.): _____

Table 1: Water features within the surveyed area (ponds, lakes, streams, wetlands, etc.; fill in table):

Type	Number, size or extent	Condition (describe)	Isolated or connected to stream? (wetlands)	Vegetation? (list)

Major structures, roads, playgrounds, parking lots, etc.:

3. Vegetation

Table 2: Vegetation type(s), dominant species in each vegetation layer (herbaceous, shrub, tree canopy), and approximate percentages of each habitat type (use Johnson and O'Neil's 2001 scheme):

Habitat Type	WATR	HWET	RWET	WLCH	WODF	WEGR	FIELD	AGPA	URBN
Approx. % cover									
Dominant herb species									
Dominant shrub species (< 5 m)									
Dominant canopy spp (> 5 m)									

Table 3: General estimate of percent tree and shrub cover:

% Cover	<5%	5-25%	26-50%	51-75%	76-100%
Herb					
Shrub					
Canopy					

Table 4: Snag abundance and size (relative to size of habitat patch):

General abundance	Absent	Low	Medium	High
Small dbh (< 10")				
Medium dbh (10-24")				
Large dbh (>24")				

Comment on general health and vitality of habitat. Is there new vegetative recruitment? Different aged trees?

Flora: If there is a particular species of plant present that is sensitive or unique in some way, list it here. Include unusually significant findings such as large clumps of ninebark, red-osier dogwood, very large trees, etc. If Oregon White Oak or other species of interest is present but not dominant its presence and relative abundance should be documented.

Rarity of habitat type: List the presence and extent of rare habitats such as oak/madrone, native grasslands (basically absent, but include non-reed canarygrass grasslands that look good), and bottomland hardwood forest (should be cottonwoods present).

4. Wildlife

Species observed (herps, fish, birds, mammals) or known to be present (include wildlife sign, such as rubs, scrapes, tracks and droppings, woodpecker sign, etc.):

5. Human disturbance

List human uses and use by domestic animals:

List proximity to residential/developed areas, and type of nearby developments/land use (may be done from aerial photos in office if not visible in the field):

Use aerial photos to assess interspersion with other natural areas (done in the office, not in the field).

6. Current restoration efforts and restoration potential:

Comment on evidence of restoration and enhancement efforts currently on the site (include notes on apparent success or failure): _____

Comment on enhancement and/or maintenance that would improve habitat. Be sure to link this information closely to the "Enhanced Score" category on the scoring sheet.

- Remove non-native plants: type _____ prevalence _____
- Upland (non-streambank) plantings are needed (describe): _____
- Streambank plantings are needed (describe): _____
- Slope stabilization: _____
- Trash or other cleanup (describe): _____
- Other (describe): _____
- Other (describe): _____

7. Additional comments:

General description of other habitat features (food sources, bird feeders, roosting, perching, nesting, etc.):

Other unique or outstanding features: _____

Other notes and comments: _____

8. Aerial photograph "to do's:"

- Delineate the habitat surveyed (all sites)
- Confirm or correct wetlands, if possible (use an encircled check - ✓; add new ones not on map)
- Correct stream lines when possible
- Mark significant patches of reed canarygrass, Himalayan blackberry, other invasives
- Mark important rare habitat patches
- Mark important single features (very large trees, etc.)
- Label habitat types (Johnson and O'Neil scheme)
- Label possible restoration sites (when not apparent from invasive delineations)

WILDLIFE HABITAT ASSESSMENT SCORING SHEET

Portland Metro Region

Observer(s): _____ Date: _____ Photos? No _____ Yes _____ Roll & Exp# _____

Site ID: _____ Site name _____ Thomas Guide # _____

Directions to site entry and extent of area surveyed: _____

Component		Range of Values			Score Existing	Score Enhanced	Comments
WATER	Seasonality and Quantity	None 0	Moderate 4	Good 8			
	Channel morphology, complexity, alteration	Poor 0	Moderate 3	Good 6			
	Proximity to cover	None 0	Near 4	Adjacent 8			
	Diversity (streams, ponds, wetlands)	Zero 0	One 4	Two 6	Three+ 8		
FOOD	Variety	Low 0	Medium 4	High 8			
	Quantity	Low 0	Medium 4	High 8			
	Seasonality	Low 0	Limited 4	Yr-round 8			
COVER	Structural diversity	Low 0	Medium 4	High 8			
	Variety and seasonality	Low 0	Medium 4	High 8			
	Nesting and denning sites	Low 0	Medium 2	High 4			
HUMAN DISTURB.	Habitat modification, structures, etc.	High 0	Medium 4	Low 8			
	Direct human disturb. (trails, road noise, pets)	High 0	Medium 3	Low 6			
UNIQUE FEATURES	Wildlife	Not diverse 0	Somewhat 2	Very 4			
	Flora	Not unique 0	Somewhat 2	Very 4			Do not score in field.
	Rarity of habitat type	Not rare 0	Somewhat 3	Very 4			Do not score in field.
	Interspersion with other habitats	Low 0	Medium 3	High 6			Done in office using aerial photos. Do not score in field.
IMPORTANT HABITAT FEATURES	Downded wood, old stumps, snags	Low 0	Medium 4	High 8			
	% nonnative herbs	100% 0	80% 1	50% 2	10% 3	0% 4	
	% nonnative shrubs	100% 0	75% 1	50% 2	25% 3	10% 4	5% 5
	% nonnative canopy	>10% 0	5% 2	3% 3	0% 6		
TOTAL SCORE:					Existing	Enhanced	

RSAT Data Form
METRO 2001 Macroinvertebrate Study

Site ID# _____ Park/Stream Name _____ Investigator(s) _____ Date _____
 Photo Roll # _____ Exposure # _____ Channel Profile: U V Trapezoid Ponded Floodplain Other _____
 Habitat type: Riffle _____ Glide _____ Sample area random #'s: Downstream 1/2 _____ Upstream 1/2 _____
 Specific directions to sampling area from point of entry (if in a bird site, include proximity to point count stations) _____

Stream Cross-section Characterizations

	CS 1	CS 2	CS 3	CS 4	CS 5	CS 6
Habitat Type						
Wetted Width (ft)						
Active Channel Width (ft)						
Bankfull Width (ft)						
Bankfull Height (ft)	L R	L R	L R	L R	L R	L R
Overbank Height (ft)	L R	L R	L R	L R	L R	L R
Left/ Right Bank Angle (°)	L R	L R	L R	L R	L R	L R
Depth (inches)	/ / / / /					
Substrate Type (cLay, Sand, Gravel, Cobble, Rubble, Boulder, Wood)	----- ----- ----- -----	----- ----- ----- -----	----- ----- ----- -----	----- ----- ----- -----	----- ----- ----- -----	----- ----- ----- -----
Embeddedness (includes sediment): 1=0-25, 2=26- 50, 3=51-75, 4=76-100%	----- ----- ----- -----	----- ----- ----- -----	----- ----- ----- -----	----- ----- ----- -----	----- ----- ----- -----	----- ----- ----- -----

Stream Channel Characterization (estimate at 150-ft reach scale)

Channel stability: Bank Material Silty soil _____ Clay-dominant _____ Bedrock _____ Other _____

Bank stability (% of reach length stable) _____ Undercut bank area (% of reach length) _____

Dominant Bed Material (riffler) Clay _____ Sand _____ Cobble/Gravel _____ Bedrock _____ Riprap _____ Other _____

Dominant Bed Material (pool/glide) Clay _____ Sand _____ Cobble/Gravel _____ Bedrock _____ Riprap _____ Other _____

Estimate % sediment deposition within each habitat type: Riffles: _____ Pools/Glides (if rocky): _____

Physical instream habitat (full transect)

% Riffle _____ % Pool _____ % Glide _____ # LWD (>6 in) in bankfull width _____

Organic layer accumulation in depositional zones: _____ inches (usually "fines" habitat, does not refer to soil-type sediments)

Filamentous Algae % coverage in reach: _____ Macrophytes: % coverage in reach: _____ Duckweed % _____

Velocity characterization

Cross-section # _____ Length (ft) _____ # seconds (use glide habitat) _____

Roughness Coefficient (cobble=0.8, mix = 0.85, fines = 0.9) _____

Water Visibility	<input type="checkbox"/> clear	<input type="checkbox"/> slightly off-color	<input type="checkbox"/> off-color/turbid	<input type="checkbox"/> tea or coffee
	<input type="checkbox"/> bright green	<input type="checkbox"/> green	<input type="checkbox"/> yellow-brown, sudsy	<input type="checkbox"/> red-orange
	<input type="checkbox"/> white, cloudy	<input type="checkbox"/> white, sudsy	<input type="checkbox"/> light to dark gray	<input type="checkbox"/> brown
	<input type="checkbox"/> yellow-brown	<input type="checkbox"/> rainbow sheen		
Water Odor	<input type="checkbox"/> None	<input type="checkbox"/> organic, earthy	<input type="checkbox"/> chlorinated	<input type="checkbox"/> petroleum
	<input type="checkbox"/> antifreeze, sickly sweet	<input type="checkbox"/> sulfurous, rotten eggs	<input type="checkbox"/> sewerage, foul	

Riparian habitat characterization

Buffer width (ft; use aerials in office unless easily measured; note if lopsided) R _____ L _____

Vegetation type and percent (30-ft radius plots; right bank @ CS #2, left bank @ CS #4)

Right bank	Native/A or I	Left Bank	Native/A or I	Dominant species (> 10% cover)
% Tree	/	% Tree	/	
% Shrub	/	% Shrub	/	
% Herb	/	% Herb	/	
Tree canopy % overhanging stream (divide stream by thalweg)		R _____	L _____	

Verts/Inverts observed outside of sample areas: _____

Document culverts and pipes/sewer outfalls, evidence of degradation in and near the transect (photos are good): _____

Document other in- and near-stream conditions of interest (i.e., beaver dams, waterfalls, weirs, oxbows, secondary channels, refugia, seeps, backwater zones, evidence of restoration efforts in and near the stream, other comments of interest): _____

What restoration/enhancement efforts might improve this area? _____

EQUIPMENT LIST

- RSAT forms and instructions
- Random numbers table
- Yardstick
- Tape measure
- Wire flags
- Flagging
- Pencils, sharpies
- Metal clipboard

D-frame net

- Metal sampling frame
- White plastic washtub
- 2 metal sieves
- 2, 5-gallon white plastic buckets
- Scrub brush
- Gloves
- Hip waders

- Tweezers
- Sample bottles
- Wash bottle
- Clear substrate viewer
- Spatula
- Funnel
- Macroinvertebrate field guide
- Hand sanitizer
- Alcohol

DEFINITIONS

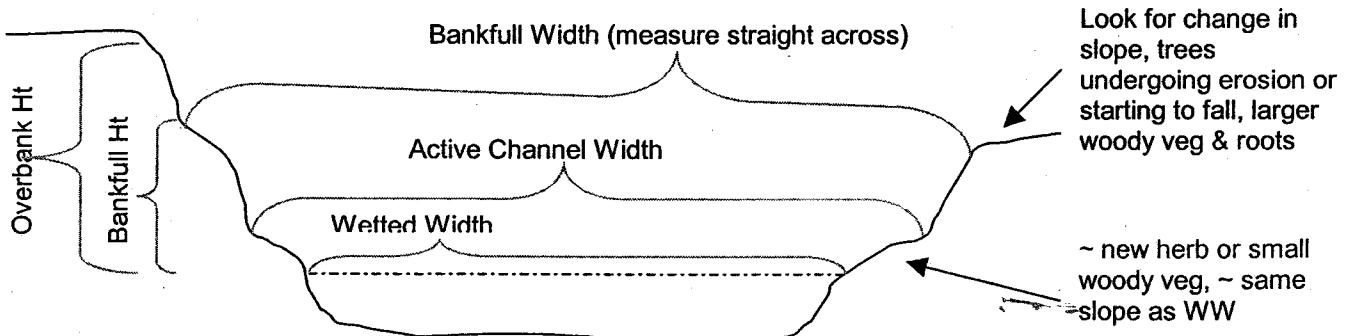
Right bank/left bank: as you view the stream facing downstream.

Site: A study site, e.g., the park or natural area being studied.

RSAT reach length: A 150' stream reach containing the macroinvertebrate sample areas. In the case of riffle habitat, the stream reach consists of the two riffles, each with two sample areas (selected using random numbers table). In the case of glide habitat, select a relatively uniform habitat area, then select the appropriate stream length in the approximate center of the habitat area. Divide the RSAT reach into 75' halves, then use the random numbers table to select two sample areas within each half.

Cross-section (transect): the six measurement areas perpendicular to the stream, typically spaced equally every 30 feet (but spaced further apart in wider streams – e.g., 20 x the stream width).

Sample area: the four macroinvertebrate sampling areas within an RSAT reach length, selected using random # table.



Portland Metro Benthic Invertebrate Analysis

July 30, 2003

Prepared for Metro Regional Services
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Executive Summary

Purpose

- Describe responses of stream invertebrates to urbanization in the greater Portland metro area (see map in Section 10; Figure 1).

Introduction

- Benthic macroinvertebrate assemblages from 54 small streams (1-8 meters wide), from the Tualatin, Clackamas, Sandy and Willamette River basins, were compared using multimetric (B-IBI) and multivariate analyses, as well as comparing means between classes of impaired, intermediate, and reference sites.
- Five sites were identified as potential reference sites prior to sampling based on their relatively intact conditions. These sites include three sites in Forest Park, McKay Creek (upper Tualatin basin), and Gordon Creek (Troutdale).

Results

- According to Oregon DEQ B-IBI scores, 43 of 54 sites (80%) show severe impairment to invertebrate communities. Six non-reference sites were moderately impaired, and clear evidence of disturbance exists.
- % forest acres in drainage, forest corridor (similar to buffer width), % riffles, and % boulder and cobble substrates were positively associated with reference sites.
- As road density in drainage (a surrogate measure of the level of urbanization), % commercial + industrial acres in drainage (associated with higher levels of imperviousness), and % clay substrate increased, B-IBI scores decreased, and stream impairment increased.
- Reference sites were crucial in finding linear trends between B-IBI scores and local and watershed conditions. With reference sites removed, very few linear correlations were significant. However, average forest canopy and B-IBI scores increased significantly from impaired, to intermediate, to reference sites.
- Severely impaired sites had abundant planktonic organisms such as copepods, Cladocera, and ostracods, and burrowing organisms including oligochaete worms, clams, and alderfly larvae. Fewer sites had abundant intolerant insects such as mayflies, stoneflies and caddisflies

(Ephemeroptera, Plecoptera, and Trichoptera, or "EPT's"), indicating better water quality conditions; most of these were reference sites.

- In multivariate analysis, "intermediate" sites were identified where % stream slope and % riffles were similar to reference conditions. Composition of stream invertebrates were also intermediate between severely impaired and reference. Intermediate sites had significantly more tree canopy and B-IBI scores, but not higher road density (urbanization levels), than impaired sites.
- Correlations between B-IBI scores and local and physical variables were moderate to strong. Forested land in the drainage and forested buffers near streams were correlated with healthy stream communities. Severely impaired stream communities were associated with high road density, reduced canopy cover, and commercial and industrial land use.

Conclusions

- Road density was only important in distinguishing reference from non-reference sites. Road densities were similar between intermediate and impaired sites. Once urbanized, forest canopy appears more important to stream health than urbanization level.
- It may be possible to bring other, more impaired sites up to the intermediate level if canopy cover was substantially increased, although it is not likely that they will ever resemble reference conditions.
- Because reference and intermediate level streams appear to be relatively scarce in the Portland metro area, their spatial distribution and potential for preservation and restoration should be evaluated. The accelerated rates of urbanization suggest that these evaluations be made in the near future.

List of Tables, Figures and Appendices

Appendix 1: Supporting Figures and Data Tables

FIGURES

- Figure 1.** Metro 2001 macroinvertebrate study sites map.
- Figure 2.** Pearson's correlations between B-IBI scores and drainage and local stream characteristics.
- Figure 3.** Benthic macroinvertebrate density comparison for glide and riffle habitats in Portland metro streams.
- Figure 4.** Comparison between B-IBI methodologies from two Pacific Northwest regions for all Portland metro stream study sites.
- Figure 5.** Oregon DEQ B-IBI score vs. % forest acres in drainage for Portland metro streams.
- Figure 6.** Oregon DEQ B-IBI score vs. forest corridor for Portland metro streams.
- Figure 7.** Oregon DEQ B-IBI score vs. % riffles at sample sites for Portland metro streams.
- Figure 8.** Oregon DEQ B-IBI score vs. % cobbles and boulders at sample sites for Portland metro streams.
- Figure 9.** Oregon DEQ B-IBI score vs. log (road density) for Portland metro streams.
- Figure 10.** Oregon DEQ B-IBI score vs. % commercial and industrial acres for Portland metro streams.
- Figure 11.** Oregon DEQ B-IBI score vs. % clay substrate at sample sites for Portland metro streams.
- Figure 12.** NMS ordination graphs for Metro sampling sites, 2002 with all sites included.
- Figure 13.** NMS ordination graphs for Metro sampling sites, 2002 with reference sites excluded.
- Figure 14.** Comparison of B-IBI scores with untransformed road density (a proxy variable for imperviousness) suggests that the threshold of impairment typically seen in urbanized areas is also seen in our study area. The four highest scoring four sites were the reference sites for which road density data was available. Stream health, as measured by B-IBI scores, declines quickly with urbanization.

DATA TABLES (Tables 1 and 2 are embedded within text)

- Table 3.** Puget Sound lowland B-IBI scoring criteria for invertebrate samples with midges identified to family and other aquatic insects identified to genus. Redrawn from Karr 1998 (in Section 10).
- Table 4.** ODEQ B-IBI scoring criteria for invertebrate samples with midges identified to sub-family or tribe and other aquatic insects identified to genus (in Section 10).
- Table 5.** Predicted response to human impact by Puget Sound Lowland and Oregon DEQ B-I. Redrawn from Karr 1998 (in Section 10).

Table 6. B-IBI metric scoring totals and corresponding stream conditions (in Section 10).

Table 7. Pearson correlation r^2 values between B-IBI scores and watershed (drainage) and local stream conditions. (-) indicates negative correlation: B-IBI scores decrease as metric increases. (+) indicates positive correlation: B-IBI scores increase as metric increases (in Section 10).

Table 8. Correlations of NMS ordination axis scores with B-IBI scores, and site-scale and landscape-scale physical variables. Two ordinations were performed: one with samples from all sites, another with samples from all sites except those considered to be reference sites. Linear correlations with $r \geq 0.45$ are bolded, indicating variables most highly correlated with variation in invertebrate communities (in Section 10).

Table 9. Summary for stream groups based on ordination analyses. All values are averages among groups (in Section 10).

Appendix 2: Interpreting invertebrates in Portland metro streams.

Appendix 3: Individual B-IBI scores for each site.

Appendix 4: Relative abundances and densities of all invertebrate taxa.

Appendix 5: Relative abundances and densities for all Ephemeroptera, Plecoptera, and Trichoptera taxa.

Introduction

Roughly 80% of the U.S. population lives in cities and suburbs (U.S. Census Bureau 2001). Urbanization is recognized as one of the leading causes of biodiversity loss (Czech et al. 2000). Declines in biodiversity follow a gradient from rural areas to the urban core (Kowarik 1995, Blair 2001, and Mackin-Rogalska et al. 1988). As human populations continue to grow, and urban areas expand, the surrounding ecosystems are continuously altered and disturbed, with accompanying changes in wildlife communities. Small-stream communities are greatly influenced by riparian vegetation (Vannote et al. 1980, Gregory et al. 1991). In small streams of the Portland metro area, in-stream organisms may be affected by losses of or changes in riparian vegetation (Palmer et al. 2000).

Prior to development, typical construction site procedures include removing most, if not all vegetation and topsoil (Sharpe et al. 1986). These practices reduce costs and increase heavy equipment mobility, but can be environmentally detrimental. These disturbances often result in fragmented patches of native habitat (Medley et al. 1995, Collins et al. 2000). The impacts of development frequently lead to intense colonization by invasive or generalist species, both plant and animal (Luken 1997, Palmer et al. 2000, McKinney 2002). Vegetation removal and alteration disturbs stream riparian corridors and often disrupts the natural flow of streams (Finkenbine et al. 2000, Palmer et al. 2000). Many species rely on intact vegetative patches and forested corridors, and the potential on-site loss can be overwhelming. Aquatic invertebrates are no exception, as many insects use streamside vegetation for much of their adult life (Meehan et al. 1977, Cummins and Klug 1979, Cummins et al. 1989, Palmer et al. 2000).

Urban settings have extensive impervious surfaces defined as roads, parking lots, sidewalks, rooftops, and all other impermeable surfaces preventing water from going subsurface (Schueler 1994). These surfaces drastically alter the natural percolation and infiltration of precipitation through and within soils. Shifts from sub-surface flow to overland runoff are typical in the Pacific Northwest (Booth and Jackson 1997). Zoning codes account for the number of houses (rooftops) in a given area, while area covered by streets, driveways, and parking lots often carry no restriction (Scheuler 1994). Development "thresholds" have been suggested by models and verified in the field (Booth 1991, Booth and Reinelt 1993, Schueler and Galli 1992). They demonstrate that stream stability and habitat quality in urban settings severely declines around levels of 10 – 15% of impervious surfaces. Studies have also linked pollution with impervious surfaces (Schueler 1987). Macroinvertebrate diversity declined consistently when impervious surfaces reached levels greater than 10 – 15% in small Maryland streams (Klein 1979).

Both vegetation loss and increased pavement ground cover alter natural hydrologic processes. Concomitantly these alterations may have profound effects on stream dynamics. For instance, total runoff volume for a one-acre parking lot is nearly 16 times that of an undeveloped meadow (Scheuler 1994). Vegetation loss and increased overland runoff may lead to stream bank failure,

erosion, and sedimentation. Reductions in riparian vegetation will have substantial effects on stream temperature, potentially reducing cool and cold-water stream species.

Aquatic invertebrates provide an excellent means to study biological responses to water and stream habitat quality. They are found in nearly every aquatic habitat, are relatively sedentary in nature and long lived; moreover, the large number of species represents a range of responses to environmental stress (Rosenburg and Resh 1993). Many aquatic invertebrates have long life cycles (1-2 years or more), increasing their susceptibility to environmental or human-caused disturbance. Disturbance or stress may result in stream communities devoid of intolerant species because many of these invertebrates are unable to disperse. In contrast to water quality characteristics that often provide only a snapshot of conditions, aquatic invertebrate assemblages are exposed to local environments for long exposure intervals and may reflect natural or anthropogenic events prior to sampling. Streams that represent a long history of disturbance will exhibit organisms that reflect these practices, and may show significant diversity loss.

Purpose

The goal of this study was to describe responses of stream invertebrates to urbanization in the greater Portland metro area. Our purpose was to identify factors contributing to stream health using the following tools:

- 1) Compare the usefulness of regionally specific Benthic indices of biotic integrity (B-IBI) for stream invertebrates.
- 2) Determine local stream and watershed conditions associated with stream invertebrate communities based on similarities using multivariate analysis and comparison of the means of groups (impaired, intermediate, and reference sites).

Collection Methods

Benthic macroinvertebrate samples and stream physical data were collected in late summer 2001 (September and October) at 54 small-stream sites (1-8 m wetted channel width) within the greater Portland metro area (Table 1; Figure 1, Appendix 1). Five sites were identified as potential reference sites prior to sampling based on their relatively intact conditions. Study reaches were 150 feet long. Quantitative invertebrate samples were collected using sampling frames (1' X 2') with sideboards to channel the invertebrates down into the 500 µm mesh net. At each site, we collected four randomly selected 2 ft² samples, two from the upstream section, and two from the downstream section for a total of 8 ft² per site following Oregon DEQ's macroinvertebrate sampling protocol (Hafele and Mulvey 1999). Invertebrates were collected from riffle habitats at 19 sites and

from glide habitats at 35 sites, based on existing predominant habitat. Samples were stored in 100% denatured ethanol.

Dominant stream habitat conditions were described for each study site. In glide habitats, organic substrates were sampled to a depth of 5 cm. In riffle habitats, all surface substrates (gravels, cobbles, etc.) within the sampling frame were sampled. It is likely that many glide sites historically contained riffle-pool sequences, now altered by hydrologic changes and sedimentation. We determined near-stream and watershed land use and landcover for each site using satellite imagery and high-resolution aerial photos.

Table 1. Portland Metro sample sites grouped by river drainage and dominant habitat.

River Drainage	# of glide sites	# of riffle sites
Tualatin	31 (1 reference site)	4
Clackamas	0	1
Sandy	1	1 (1 reference site)
Willamette mainstem	3	13 (3 reference sites)

Laboratory and Data Analysis

Samples were sorted and identified at Oregon State University, Department of Fisheries and Wildlife. Most samples were sub-sampled using a gridded sieve (Caton 1991). At least 500 organisms (or 100% of sample) were counted from each combined site sample. Sub-sample proportions ranged from 3.3% to 100%. Total macroinvertebrate abundances (calculated by multiplying sub-samples) were used in analyses.

Most aquatic insects were identified to genus, and non-insects were identified to family or order. Benthic-Index of Biotic Integrity (B-IBI) scores were calculated using B-IBI developed for the Puget Sound lowlands (Karr 1998) and B-IBI developed in the Oregon Coast range (Hafele and Mulvey 1999). B-IBI assessments are made by compiling scores from several metrics for each site (Tables 2 and 3, Appendix I). Individual metrics including "taxa richness", "long-lived taxa", and "intolerant taxa" respond to increasing levels of human impact (Table 4, Appendix I). See Appendix III for individual metric scores for each site. Mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera), are aquatic insects that have exposed gills and are generally indicative of clear, well-oxygenated waters; they often indicate clean streams with low sedimentation; we combined these three orders as an accessory metric in site group analysis.

Metrics are similar between the two B-IBI methodologies, though some are unique to each assessment. We deviated from Puget Sound lowlands protocol by combining the four samples from each site before counting invertebrates. The Puget Sound lowlands B-IBI genus level 10 assessment uses identification of midges (Chironomidae) to family, but other invertebrates are identified to genus or lowest resolution necessary. The Oregon B-IBI level 3 assessment uses identification of midges (Chironomidae) to subfamily or tribe and other invertebrates to genus, species, or lowest resolution necessary. We followed midge identification protocols according to each assessment.

Mann-Whitney Rank-Sum tests were used to evaluate differences in B-IBI scores between glide and riffle habitats. To examine how B-IBI scores change in relation to physical and environmental conditions, we calculated Pearson's correlations between B-IBI scores and several drainage and local stream characteristics. B-IBI scores between both methodologies were examined to determine how each approach fit Portland metro streams.

To compare invertebrate assemblages between sites (comparing membership of all organisms at each site), we used multivariate analysis (non-metric multi-dimensional scaling: NMS ordination); this technique measures similarity among sites based on both the kinds and abundances of invertebrates (Minchin 1987, Faith and Norris 1989, McCune et al. 2002).

Results and discussion

Figure 2 in Appendix 1 shows some key relationships between B-IBI scores and drainage and local stream characteristics. Densities of organisms varied greatly among sites (Figure 3, Appendix I). The mean density for glide samples was 603.6 organisms / ft². The mean density for riffle samples was 287.9 organisms / ft². We estimate that glide samples, on average have densities nearly twice (1.85 times) that of riffle samples. Relative abundances and densities of all invertebrate taxa are listed in Appendix IV.

According to B-IBI scoring, most streams in the Portland Metro area are impaired. Median ODEQ B-IBI scores for glides (14) and riffles (18) indicate severe impairment to benthic invertebrate communities (Table 6, Appendix I); differences between habitat types were significantly different as measured by the Mann-Whitney Rank-Sum test. Median Puget Sound lowland scores for glides (20) and riffles (18) indicated severe impairment. Scores ranged broadly from severely impaired (10-19) to good or not impaired (> 38) stream conditions, but 43 sites received very low scores.

The two B-IBI approaches were strongly correlated ($r^2 = 0.788$). Because results were similar and highly correlated between the two methodologies, we will report primarily Oregon DEQ scores. Based on B-IBI's as biological indices, reference sites were easily distinguished from other sites (Figure 5, Appendix 1).

Reference sites received B-IBI scores of 28, 30, 32, 36, and 42. Three of the five

reference sites showed slight impairment, and only one, in Forest Park, demonstrated no impairment or excellent conditions. One reference site was moderately impaired. A few other streams were not severely impaired: six streams were moderately impaired, four of which were "intermediate sites".

When reference sites were included in the analysis, B-IBI scores were significantly correlated with several watershed drainage characteristics. Scores increased as % forest acres in drainage, forest corridor in drainage, % riffles, and % cobble and boulder substrate increased (Figures 5-8, Appendix 1). When road density in drainage, % commercial + industrial acres in drainage, and % clay substrate increased, scores decreased (Figure 9-11, Appendix 1). Reference sites were critical to finding trends in these analyses. With reference sites removed, only % commercial + industrial acres in drainage showed a significant trend with B-IBI scores. However, further analysis between three site classes – impaired, intermediate and reference – showed differences, and these are discussed below.

In the urban environment, the amount of forested acres and forest corridor (similar to buffer width) in a drainage likely represents a gradient towards less disturbance. In our study, sites with more forested acres typically had higher B-IBI scores (Figures 5 and 6, Appendix I). With reference sites included, B-IBI scores increased as % riffles and % cobble + boulder substrate increased (Figures 7 and 8, Appendix I). These habitat characteristics can reflect natural elevational gradients as well as potential changes due to sedimentation and channel disturbances.

Other measures identified negative associations with disturbance and habitat alteration. As road density increased, B-IBI scores decreased (Figure 9, Appendix I). Commercial and industrial acreage did not occur upstream of reference sites; at other locations, B-IBI scores tended to decrease as % commercial + industrial acres in drainage increased (Figure 10, Appendix I). Also, B-IBI scores decreased as % clay substrate increased (Figure 11, Appendix I). Though these streams may have been dominated by clay historically, increased overland runoff could have increased channel scouring, substrate removal, and subsequent alterations towards clay.

Using multivariate analysis (NMS ordination) to identify trends among invertebrate assemblages, we identified a strong gradient from sites with abundant planktonic microcrustacea (copepods, cladocera, and ostracods) and burrowing organisms (oligochaete worms, clams, and alderfly larvae) to those with insects intolerant of slow water or fine sediments, i.e. mayflies, stoneflies and caddisflies (EPT organisms) (axis 1, Figure 12, Appendix I). Sites with very abundant microcrustacea and burrowers dominated glide/pool habitats with clay substrates. Sites with more abundant EPT organisms dominated riffle habitats with larger/coarser substrates. In this multivariate analysis, sites were strongly associated with local habitat gradients along axis 1. Landscape variables were not as good descriptors, but more forest acres in the watershed and more forest corridors were associated with higher EPT's. When reference sites were

removed from the ordination, the same trends were observed (Figure 13, Appendix I).

An important result of the multivariate ordination was identification of sites demonstrating "intermediate" physical conditions and biological assemblages (Figure 12, Appendix I). Habitat played a major role in distinguishing these assemblages; 14 of 16 sites we grouped as "intermediate" were riffle sites, and were clearly separated from glide habitats. These sites were more related to reference sites in the ordination, and invertebrates present suggested fair to good water quality and stream conditions. B-IBI scores between intermediate and impaired streams were different (Table 2), as were % slope, % riffles and % clay were significant (Table 9, Appendix I). Reference sites differed from other sites in these categories, and also in the number of road crossings per stream mile in the drainage, % stream links, stream velocity, % EPT's and % Oligochaeta worms.

To further assess key differences between impaired and intermediate sites, we used t-tests to compare averages for forest canopy and road density measures (Table 2). We only statistically analyzed impaired and intermediate differences, because these are the key relationships of interest; conditions in reference conditions were clearly different from impaired or intermediate sites.

Note that the forest canopy cover variables are significantly different between impaired and intermediate sites, but road density is not significantly different (Table 2). This suggests that once the "urban threshold" has been reached – that is, once a drainage goes beyond the threshold of imperviousness typically indicative of degraded conditions – forest canopy cover is a very important contributor to stream health. The urban threshold is clearly visible in our study by examining the raw (untransformed) road density data in Figure 14 (Appendix 1). The B-IBI scores are significantly higher in intermediate sites, and it is likely that more forest canopy in these sites helps maintain hydrologic and physical habitat conditions important to stream health.

Table 2. Comparison of key variables between impaired and intermediate sites.

	Impaired	Intermediate	Reference
% forest canopy cover within 300 ft of stream (per linear ft of stream)	36% ¹	48% ¹	130 ²
Percent forest canopy cover within drainage area (% per acre)	18% ¹	25% ¹	71%
Road density in drainage area (ft/acre)	10,805	9,644	2,206
B-IBI scores (Oregon DEQ)	14.1 ¹	16.8 ¹	33.6

¹ Denotes statistically significant difference ($P < 0.05$, one-tailed t-test for two means).

² These statistics are >100% because calculated by stream length (acres of forest in buffer / stream length), not the area within 300 ft of streams. Actual canopy cover is about a third less in each category.

Conclusions

Among the 54 urban stream sites examined, reference streams in highly forested drainages stood out. Both B-IBI analyses using metric scores determined that a majority of streams were severely impaired. These low scores, indicating degraded habitat, are typical for major metropolitan areas in the Pacific Northwest (Karr and Chu 1999, Fore et al. 2001). Only 3.8% of Portland Metro sites were in good or excellent condition (B-IBI score ≥ 38); in the Puget Sound lowlands, 10% of sites were grouped in this range (Morley and Karr 2002).

Within the group of study streams, 16 sites exhibited "intermediate" conditions identified only in multivariate ordination. Most of these sites were dominated by riffle habitat. Though the majority of study sites are presently unsuitable for cold, clean-stream biota, invertebrate composition and physical conditions at "intermediate" sites suggest potential for restoration.

Increased macroinvertebrate density may inaccurately be viewed as a healthy feature of stream ecosystems. Increased macroinvertebrate density is not necessarily synonymous with increased diversity, nor does density inform us about pollution tolerant/intolerant taxa. In this study, most glide sites had high numbers of few taxa, while most riffle sites had lower densities but greater diversity. We associate higher invertebrate diversity with greater variety in habitat and food resources. Slower current velocities, and fine, soft substrates allow particular taxa to reach greater densities, and reduce potential for diversity. These conditions may not be adequate for EPT's and other riffle invertebrates. Under these degraded circumstances, some species of Diptera (true flies) and tubificid worms may increase numerically in response to organic pollution (Norris and Georges 1993). It is important to note that our study took place in an extremely dry year (2001). This may have had significant effects on density, abundance, behavior, or timing of emergence of the invertebrates in our study streams.

Disturbances in the landscape, particularly road density (a surrogate measure of urbanization) and the proportion of commercial + industrial acres, were associated with low B-IBI scores in the Portland Metro sites. Road densities for reference, intermediate, and other sites are 22.1, 96.4, and 108.1 street feet / acre, respectively. As a contrast, road densities at reference sites were much lower. It is likely that the suggested 10-15% impervious surface threshold has been exceeded in both intermediate and other sites.

The kinds of invertebrates represented in the B-IBI's were distinctive at reference sites where intolerant taxa were common, and EPT's were more abundant. Thus, reference sites reflected positive gradients responding to higher proportions in forested lands and riffles in the stream. Similar correlations between B-IBI scores and % conifer land cover, % intense urban land cover, and impervious surface area were described in the Puget Sound basin (Morley and Karr 2002).

Rather than gradual responses to physical gradients, stream communities may experience a threshold of tolerance to disturbance, pollution, or land use. This threshold may be represented by the difference between "reference" and "non-reference" sites. In our study, only 10 of 48 non-reference sites had road densities less than 50 street feet/drainage acre, but only 3 of these sites were classified as "intermediate". Because the majority of Portland Metro streams are severely degraded, it appears that a threshold for invertebrate habitat has been exceeded. Under these degraded conditions, mayflies, stoneflies, and caddisflies were typically absent and tolerant organisms such as chironomids and tubificid worms were abundant.

However, further analysis revealed significant differences in forest canopy between impaired and intermediate sites, suggesting that forest canopy can help mitigate the effects of urbanization, essentially raising the "urban threshold" to some degree.

In other urban settings, conservation of riparian conditions and wetlands are key to maintaining biological integrity (Morley and Karr 2002). Aerial imagery of our study sites revealed very little to no riparian vegetation at many sites; as percent forest acres within a drainage is one factor that distinguishes between reference, intermediate and impaired sites, protecting or enhancing riparian corridors will likely improve stream health. Because "intermediate" condition sites were typically dominated by riffle habitat, maintaining suitable riffle habitat will also be important for conserving or preserving streams. A preliminary examination of where "intermediate" streams were located suggests that the hills associated with the west bank of the Willamette River, including the Tualatin Hills, are potentially important remnants of less degraded streams. Without management intervention and restoration, habitat and water quality degradation at these sites may escalate.

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Appendix I: Tables and Figures

Tables 1 and 2 are embedded within the text.

Table 3. Puget Sound lowland B-IBI scoring criteria for invertebrate samples with midges identified to family and other aquatic insects identified to genus. Redrawn from Karr 1998.

Metric	Scoring Criteria		
	1	3	5
Total number of taxa	0-13.9	14-28	>28
Number of Mayfly taxa	0-3.5	3.5-7	>7
Number of Stonefly taxa	0-2.6	2.7-5.3	>5.3
Number of Caddisfly taxa	0-2.6	2.7-5.3	>5.3
Number of long-lived taxa	0-3.9	4-8	>8
Number of intolerant taxa	0-1.9	2-4	>4
% of tolerant individuals	>44%	27-44%	<27%
% of predator individuals	0-4.4%	4.5-9%	>9%
Number of clinger taxa	0-7.9	8-16	>16
% dominance (3 taxa)	≥75%	55-74.9%	0-54.9%

Table 4. ODEQ B-IBI scoring criteria for invertebrate samples with midges identified to sub-family or tribe and other aquatic insects identified to genus (Hafele and Mulvey 1999).

Metric	Scoring Criteria		
	1	3	5
Total number of taxa	< 19	19-35	> 35
Number of Mayfly taxa	< 4	4-8	> 8
Number of Stonefly taxa	< 3	3-5	> 5
Number of Caddisfly taxa	< 4	4-8	> 8
Number of sensitive taxa	< 2	2-4	> 4
Number of sediment sensitive taxa	0	1	> 1
Modified Hilsenhoff Biotic Index	> 5.0	4.0-5.0	< 4.0
% tolerant taxa	> 45 %	15-45 %	< 15 %
% sediment tolerant taxa	> 25 %	10-25 %	< 10 %
% dominance (single taxa)	> 40 %	20-40 %	< 20 %

Table 5. Predicted response to human impact by Puget Sound Lowland and Oregon DEQ B IBI. Redrawn from Karr 1998.

Puget Sound Lowlands Metric	Predicted Response to Increasing Human Impact	Oregon-DEQ Metric	Predicted Response to Increasing Human Impact
Total # of taxa	Decrease	Total # of taxa	Decrease
# of mayfly taxa	Decrease	# of mayfly taxa	Decrease
# of stonefly taxa	Decrease	# of stonefly taxa	Decrease
# of caddisfly taxa	Decrease	# of caddisfly taxa	Decrease
# of long-lived taxa	Decrease	# of sensitive taxa	Decrease
# of intolerant taxa*	Decrease	# of sediment sensitive taxa	Decrease
% of tolerant taxa*	Increase	Modified Hilsenhoff Biotic Index	Increase
% of predator taxa	Decrease	% tolerant taxa*	Increase
# of clinger taxa	Decrease	% sediment tolerant taxa*	Increase
% dominance (3 taxa)	Increase	% dominance (single taxa)	Increase

*denotes tolerant or intolerant to organic pollution.

Table 6. B-IBI metric scoring totals and corresponding stream conditions.

Combined Metric Score	Stream Condition
<i>Puget Sound Lowlands</i>	
46-50	excellent
38-44	good
28-36	fair
18-26	poor
10-16	very poor
<i>Oregon-DEQ</i>	
> 39	No impairment: passes level 3 assessment. Indicates good diversity of invertebrates and stream conditions with little or no disturbance.
30-39	Slight impairment: evidence of some impairment exists.
20-29	Moderate impairment: clear evidence of disturbance exists.
<20	Severe impairment: conditions indicate a high level of disturbance.

Table 7. Pearson correlation r^2 values between B-IBI scores and watershed (drainage) and local stream conditions. (-) indicates negative correlation: B-IBI scores decrease as metric increases. (+) indicates positive correlation: B-IBI scores increase as metric increases.

Drainage Correlations	PS B-IBI (all sites)	PS B-IBI (w/o reference sites)	ODEQ B-IBI (all sites)	ODEQ B-IBI (w/o reference sites)
log road density (feet / acre) (excludes LO01)	0.502* (-)	0.044 (-)	0.497* (-)	0.054 (-)
% forest acres in drainage (excludes CO01 and LO01)	0.417* (+)	0.009 (+)	0.385* (+)	0.118 (+)
forest corridor (forest acres within 300' / total stream feet) (excludes LO01 and MCCR)	0.353* (+)	0.066 (+)	0.284* (+)	0.085 (+)
vegetation corridor (all veg. acres within 300' / total stream feet) (excludes LO01 and MCCR)	0.141 (+)	0.089 (+)	0.085 (+)	0.05 (+)
% commercial and industrial acres in drainage (excludes LO01)	0.194* (-)	0.165* (-)	0.157* (-)	0.116 (-)
% residential acres in drainage (excludes LO01)	0.116 (-)	< 0.001 (-)	0.142 (-)	0.007 (-)
Local Stream Correlations	PS B-IBI (all sites)	PS B-IBI (w/o reference sites)	ODEQ B-IBI (all sites)	ODEQ B-IBI (w/o reference sites)
% riffles (excludes MI01 and PO01)	0.484* (+)	0.069 (+)	0.487* (+)	0.101 (+)
% pools (excludes MI01 and PO01)	0.082 (-)	0.026 (-)	0.094 (-)	0.039 (-)
% glides (excludes MI01 and PO01)	0.103 (-)	< 0.001 (-)	0.095 (-)	< 0.001 (-)
% clay substrate (excludes HB06 and MI01)	0.131 (-)	0.007 (-)	0.192* (-)	0.072 (-)
% cobble and boulder (excludes HB06 and MI01)	0.296* (+)	0.022 (+)	0.349* (+)	0.064 (+)

* Bonferroni adjusted significant p-values (≤ 0.0045). A Bonferroni adjustment was made to account for the increased probability of an erroneously significant correlation when many correlations are performed.

Table 8. Correlations of NMS ordination axis scores with B-IBI scores, and site-scale and landscape-scale physical variables. Two ordinations were performed: one with samples from all sites, another with samples from all sites except those considered to be reference sites. Linear correlations with $r \geq 0.45$ are bolded, indicating variables most highly correlated with variation in invertebrate communities.

		All sites n=54			Without reference sites n=49		
		Axis 1 $R^2=0.64$	Axis 2 $R^2=0.14$	Axis 3 $R^2=0.07$	Axis 1 $R^2=0.48$	Axis 2 $R^2=0.22$	Axis 3 $R^2=0.11$
BIBI	ODEQ-BIBI	0.69	-0.22	-0.40	0.28	-0.08	-0.43
	KARR- BIBI	0.66	-0.32	-0.34	0.20	-0.01	-0.34
Landscape Variables	log(drainage area)	-0.09	-0.51	0.19	-0.19	-0.30	0.47
	road density	-0.41	0.49	0.14	-0.08	0.35	-0.17
	log((%ag(sat)+0.1)*10)	-0.24	-0.26	0.08	-0.08	-0.37	0.21
	% forest (sat)	0.46	-0.12	-0.05	0.19	0.00	0.01
	% all vegetation (sat)	0.41	-0.41	-0.01	0.29	-0.35	0.22
	% forest (digit.)	0.50	-0.17	-0.17	0.38	-0.16	-0.11
	forest corridor (acres within 300' / stream feet)	0.48	-0.06	-0.12	0.41	-0.09	-0.16
	veg. corridor (acres / stream feet)	0.26	-0.26	-0.16	0.24	-0.41	-0.03
	% commercial/industrial (digit.)	-0.41	-0.03	0.34	-0.28	0.18	0.33
	% residential (digit.)	-0.19	0.48	0.08	0.07	0.35	-0.29
	street crossings / mile of stream channel	-0.32	0.03	0.00	-0.16	0.13	0.10
	% stream links**	-0.17	-0.32	-0.24	-0.08	-0.30	-0.21
Local Site Variables	log(%riffl+1)	0.85	-0.02	-0.03	0.80	0.07	-0.06
	arcsin(%glides+pools) ²	-0.86	0.09	0.14	-0.77	-0.02	0.07
	log(avg depth)	-0.49	-0.19	0.10	-0.44	-0.22	0.19
	log(max depth)	-0.39	-0.21	0.22	-0.36	-0.17	0.26
	log((avg flow+0.01)*100)	0.45	-0.16	0.34	0.35	0.11	0.37
	% clay substrate	-0.77	0.06	-0.16	-0.77	-0.04	-0.15
	% bank stability	0.28	-0.04	-0.49	-0.09	-0.06	-0.40
	gradient (% stream slope)	0.62	-0.11	0.10	0.54	-0.50	-0.14

Table 9. Summary for stream groups based on ordination analyses. All values are averages among groups.

criteria	impaired (n=33)	intermediate (n=16)	reference (n=5)
Oregon Coast B-IBI score	14.1	16.8	33.6
Puget Sound lowland B-IBI score	17.5	18.6	36.8
# road crossings / stream mile in drainage*	2.8	2.4	0.8
% stream links*	7.3	7.5	0.0
% slope*	2.3	8.9	19.0
velocity (ft/sec)	0.3	0.3	1.0
% riffles	2.0	33.5	74.6
% clay	60.1	17.3	5.6
% Ephemeroptera, Plecoptera and Trichoptera	0.4	20.1	53.8
% Oligochaeta worms	32.2	12.3	5.8

* LO01 excluded (no data)

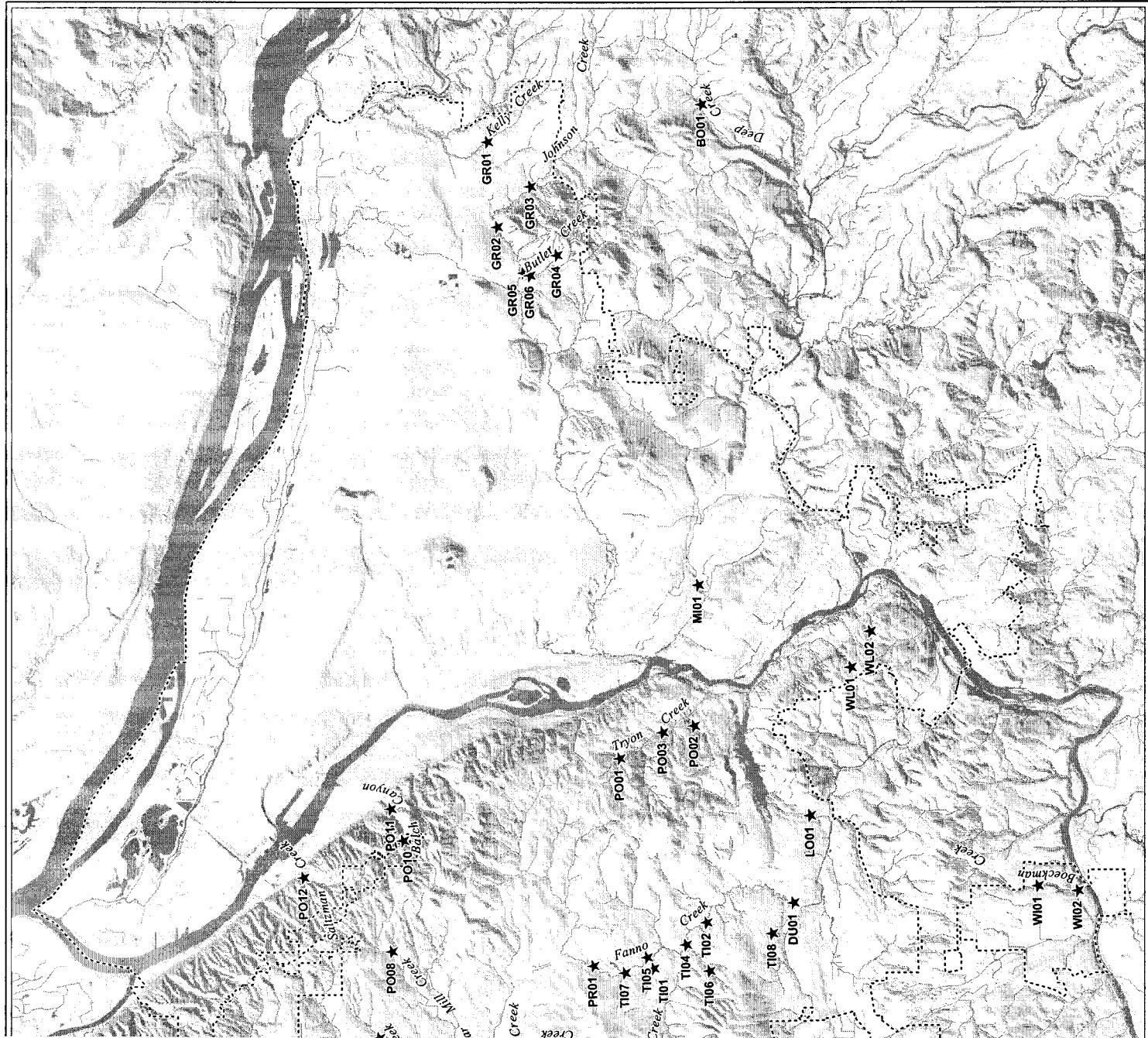




Figure 1: Study Sites Map is attached separately as a PDF file.

**Figure 2. Pearson's correlations
between B-IBI scores and drainage and
local stream characteristics**
(significant at $p < 0.05$, w/ Bonferroni adjustment)

All sites (54)

positive correlations

- % forest acres in drainage
- forest corridor @ site
- % riffles
- % cobble and boulder substrate

negative correlations

- log road density in drainage
- % commercial and industrial acres in drainage
- % clay substrate

Without reference sites (49)

positive correlations

- no statistically significant relationships

negative correlations

- % commercial and industrial acres in drainage

Conclusions

- B-IBI scores were higher in sites associated with greater forest acres in drainage and wider forested buffers (forest corridor)
- B-IBI scores were lower in sites associated with greater industrial and commercial land use

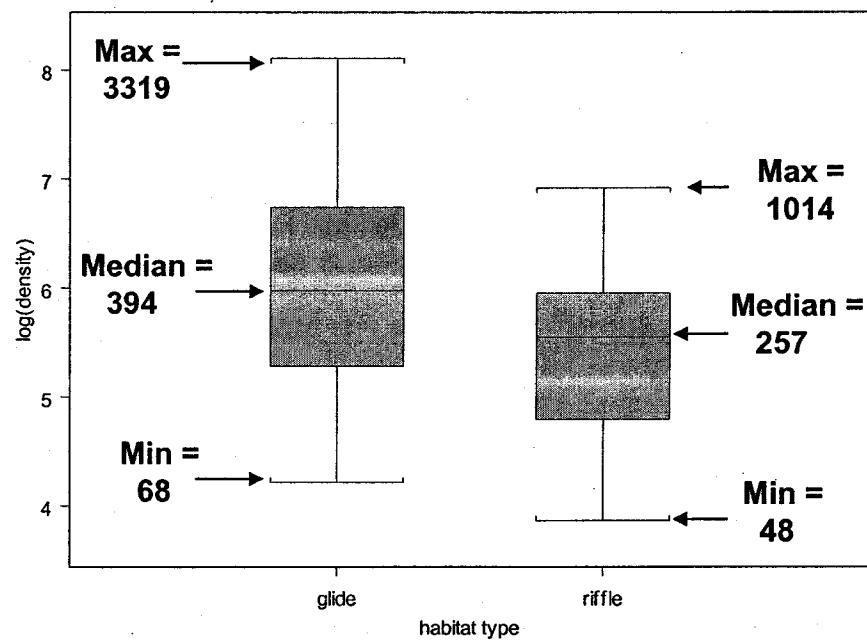


Figure 3. Benthic macroinvertebrate density comparison for glide and riffle habitats in Portland metro streams.

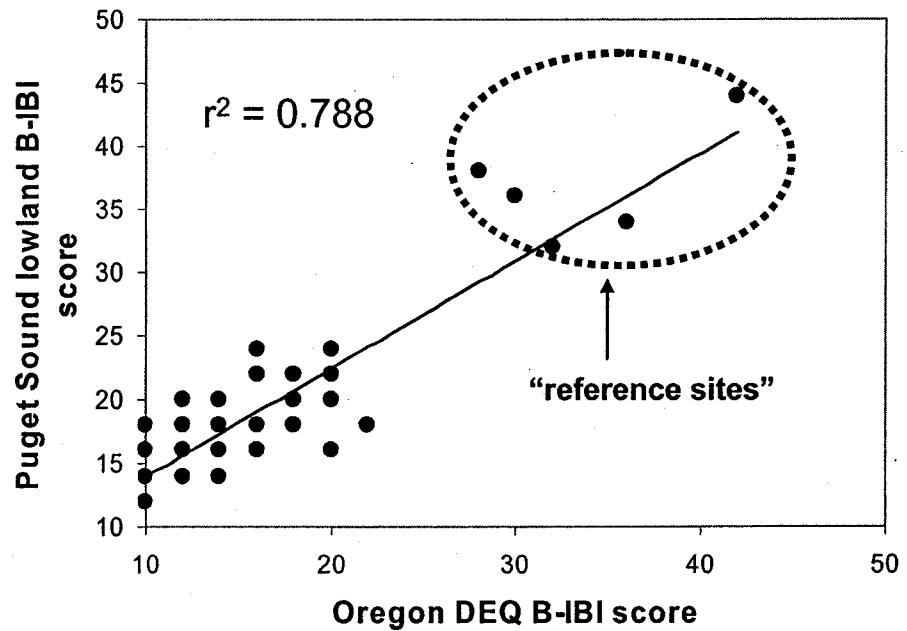


Figure 4. Comparison between B-IBI methodologies from two Pacific Northwest regions for all Portland metro streams.

Appendix I (cont.): Tables and Figures

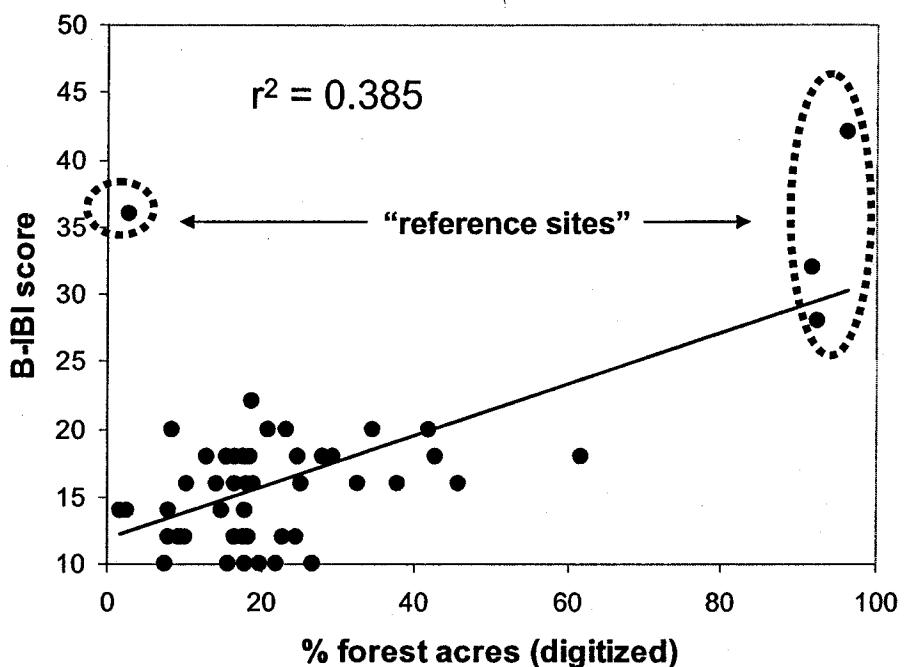


Figure 5. Oregon DEQ B-IBI score vs. % forest acres in drainage for Portland metro streams (excluding CO01, LO01, and MCCR, no data)

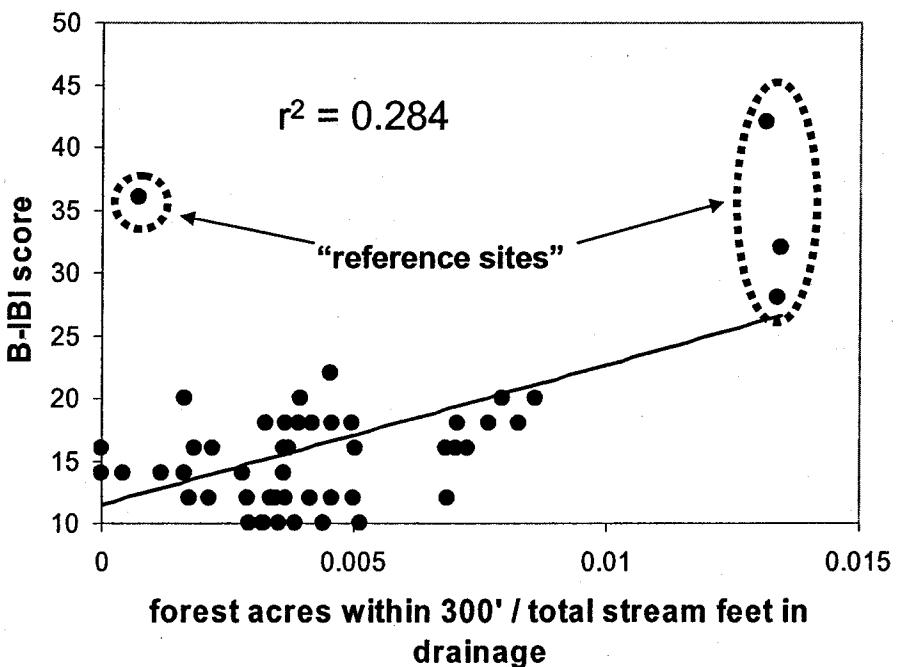


Figure 6. Oregon DEQ B-IBI score vs. forest corridor for Portland metro streams (excluding LO01 and MCCR, no data).

Appendix I (cont.): Tables and Figures

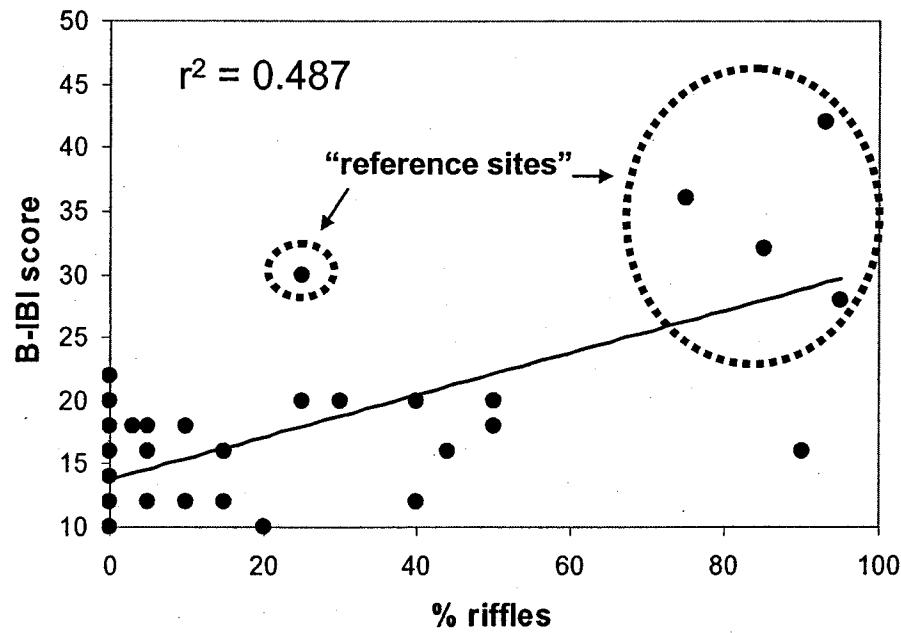


Figure 7. Oregon DEQ B-IBI score vs. % riffles at sample site for Portland metro streams (excluding MI01 and PO01, no data).

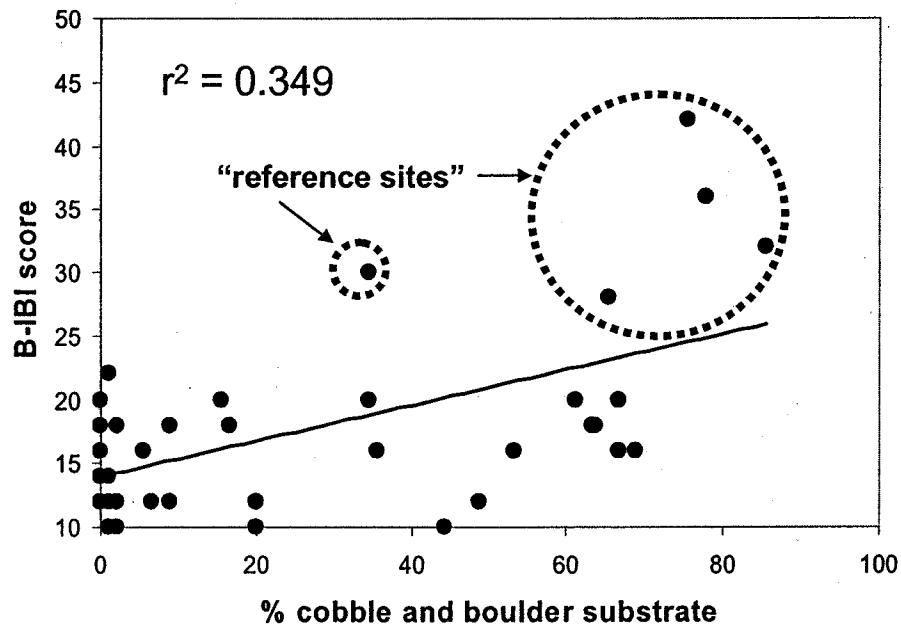


Figure 8. Oregon DEQ B-IBI score vs. % cobbles and boulders at sample site for Portland metro streams (excluding HB06 and MI01, no data).

Appendix I (cont.): Tables and Figures

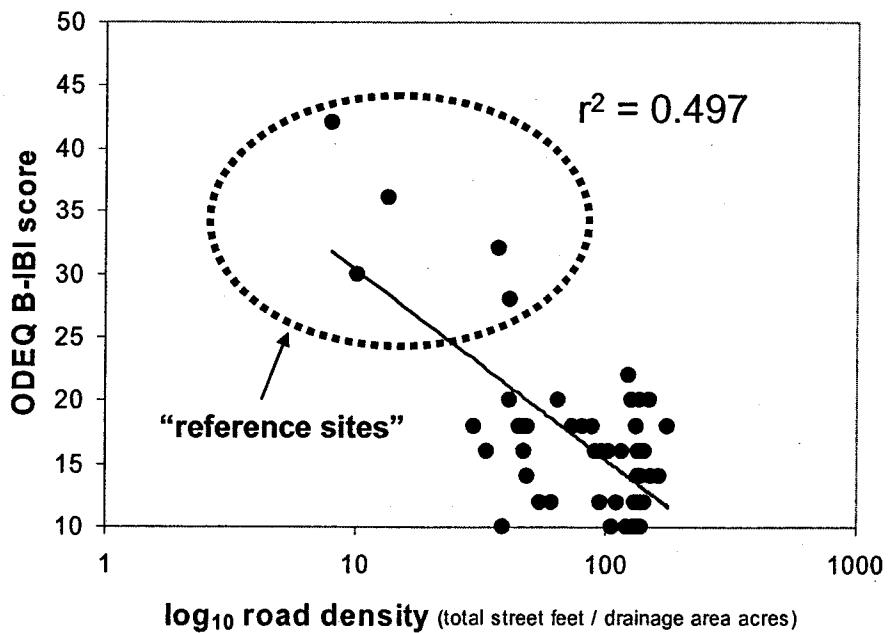


Figure 9. Oregon DEQ B-IBI score vs. \log (road density) for Portland metro streams (excluding LO01, no data)

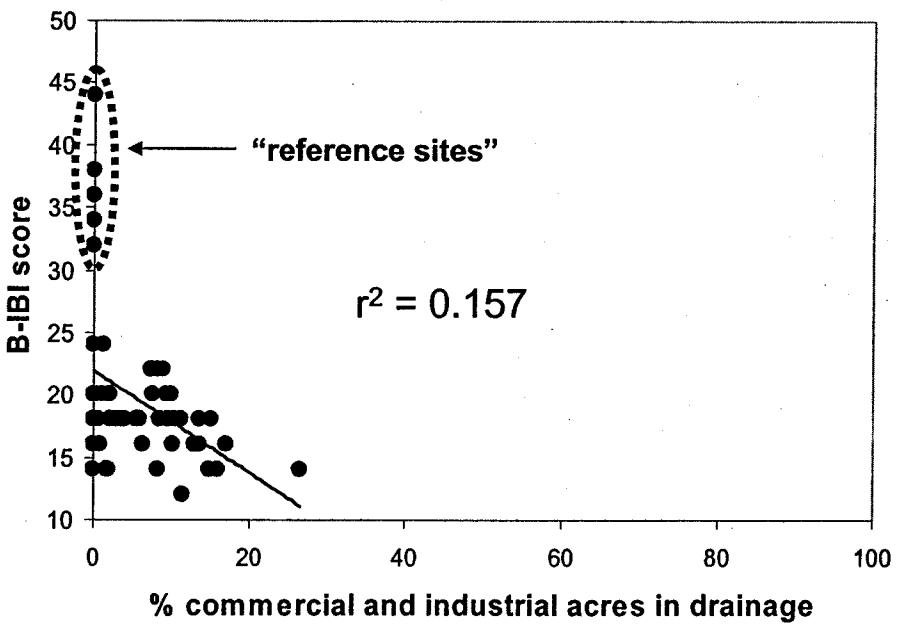


Figure 10. Oregon DEQ B-IBI score vs. % commercial and industrial acres in drainage for Portland metro streams (excluding LO01, no data).

Appendix I (cont.): Tables and Figures

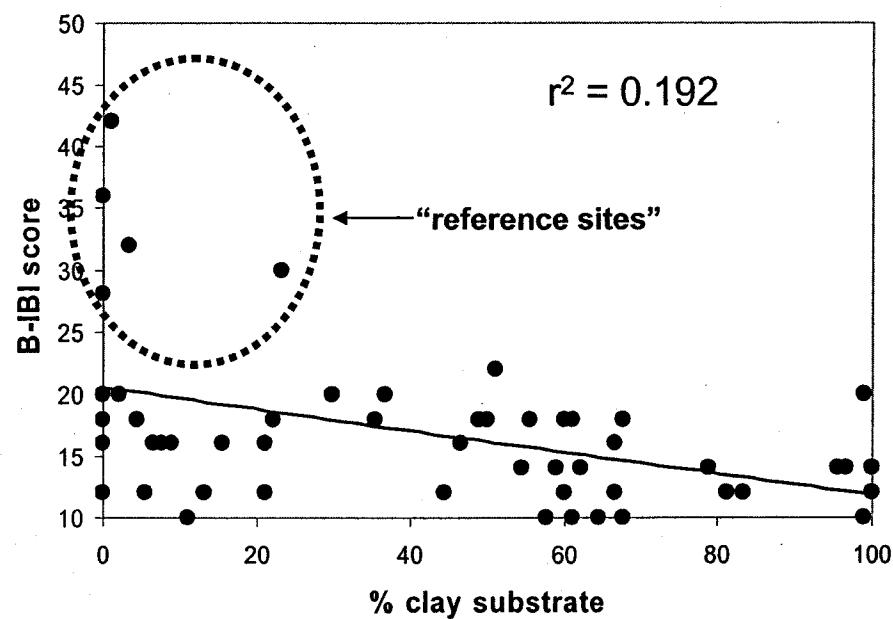


Figure 11. Oregon DEQ B-IBI score vs. % clay substrate at sample site for Portland metro streams (excluding HB06 and MI01, no data).

Appendix I (cont.): Tables and Figures

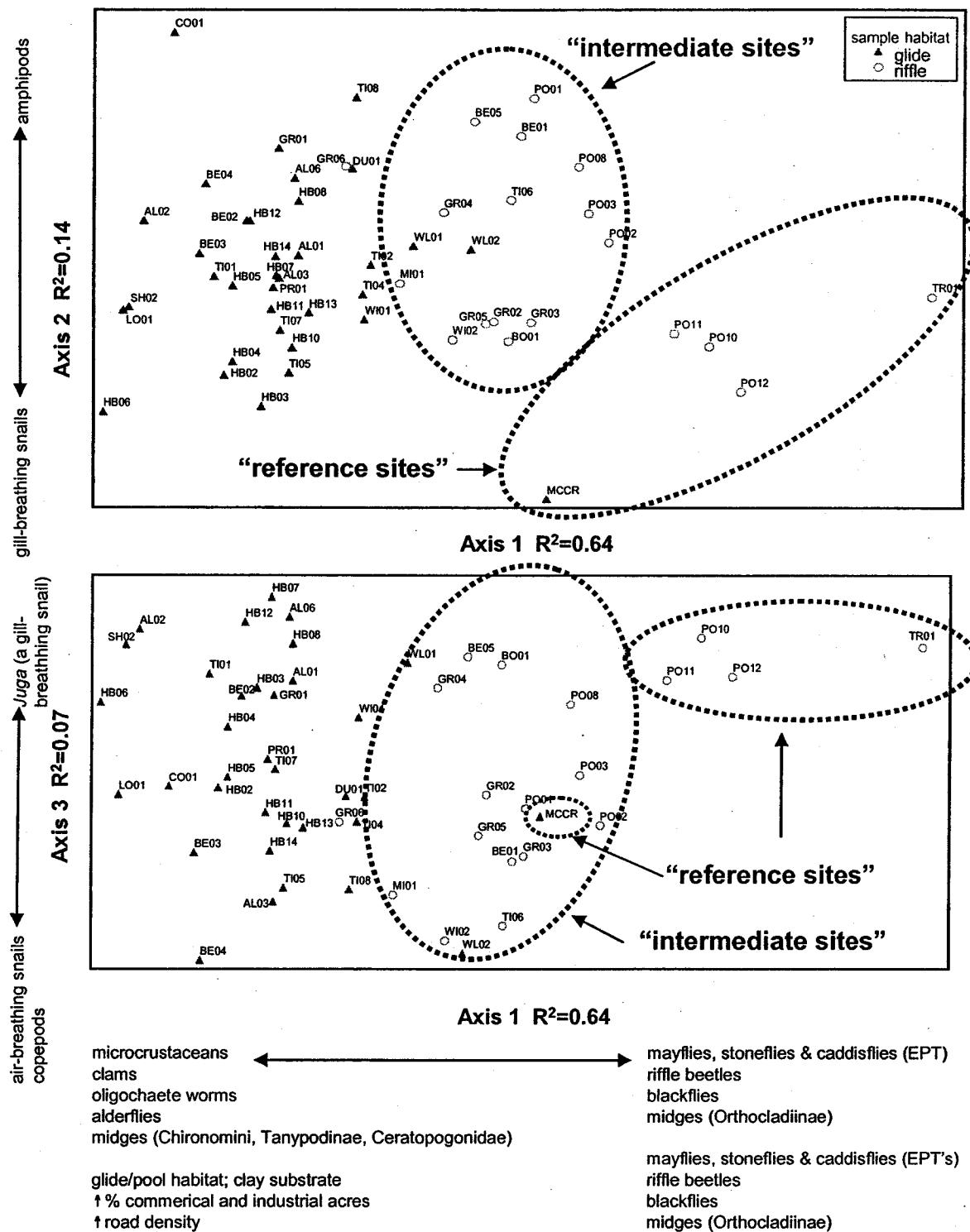


Fig. 12. NMS ordination graphs for Metro sampling sites, 2002 with all sites included. Symbols represent sites. Reference sites are TR01, PO10, PO11, PO12, and MCCR. Proximity of symbols indicates the degree of similarity in macroinvertebrate taxonomic composition and abundance. Sample symbols are coded to show habitat sampled at the site. Taxa listed are those that increase/decrease in abundance along the adjacent axis.

Appendix I (cont.): Tables and Figures

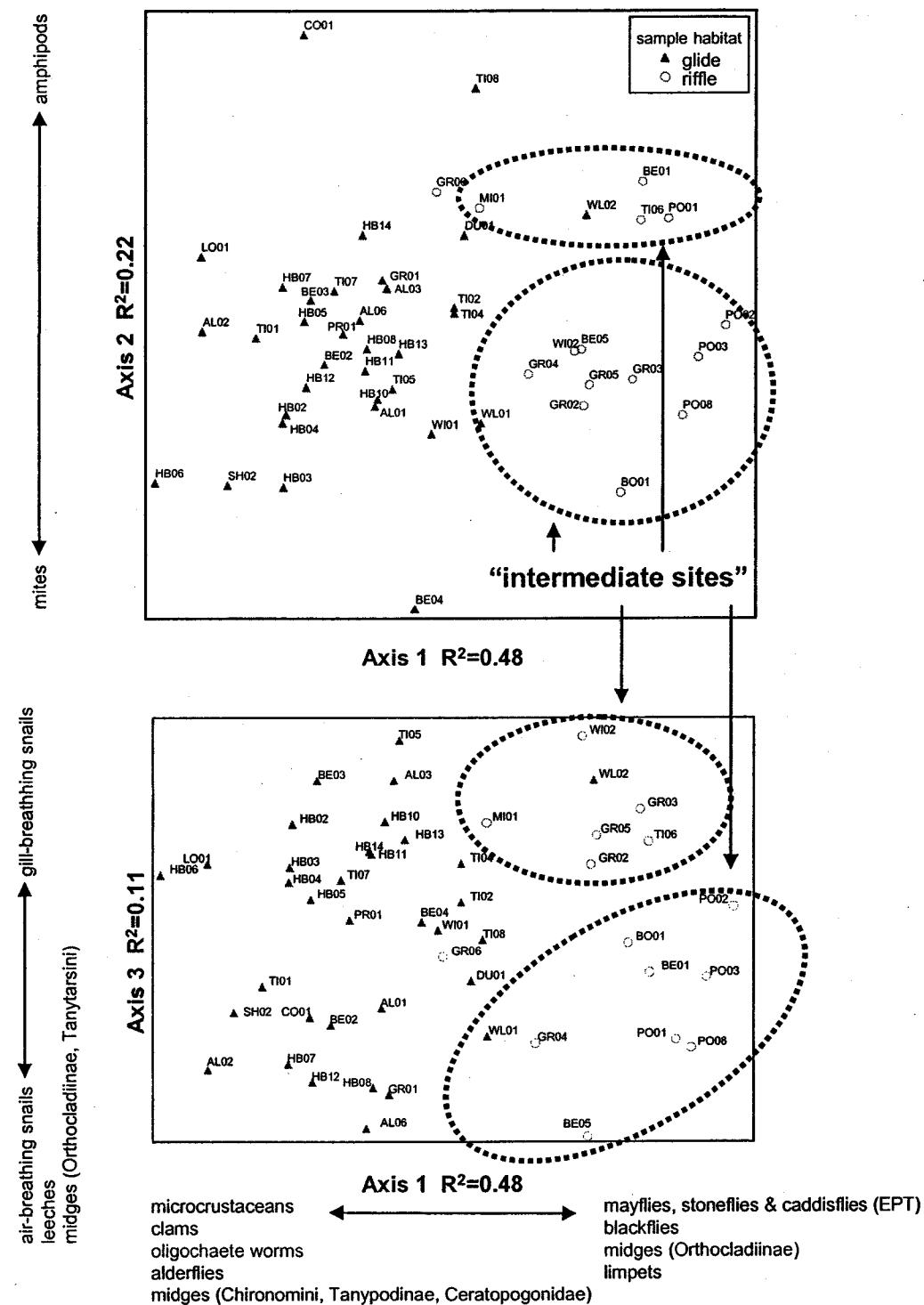


Fig. 13. NMS ordination graphs for Metro sampling sites, 2002 with reference sites excluded. Symbols represent sites. Proximity of symbols indicates the degree of similarity in macroinvertebrate taxonomic composition and abundance. Sample symbols are coded to show habitat sampled at the site. Taxa listed are those that increase/decrease in abundance along the adjacent axis.

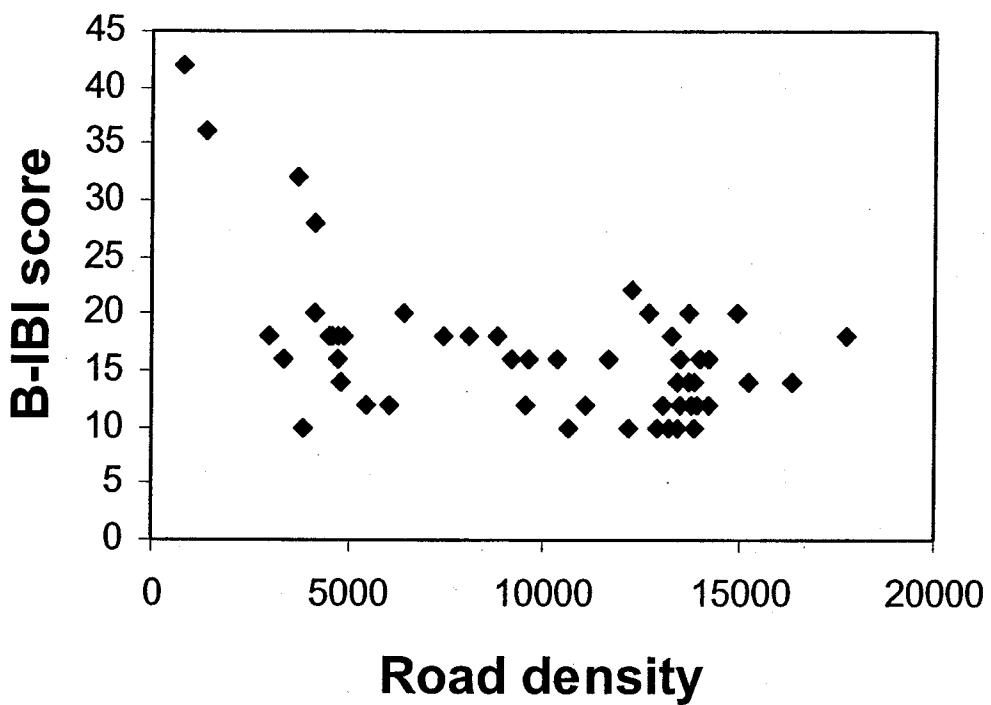


Fig. 14. Comparison of B-IBI scores with untransformed road density (feet per acre; a proxy variable for imperviousness) suggests that the threshold of impairment typically seen in urbanized areas is also seen in our study area. The four highest scoring four sites were the reference sites for which road density data was available. Stream health, as measured by B-IBI scores, clearly declines quickly with urbanization.

Appendix II: Interpreting invertebrates in Portland metro streams

Of the 54 sites, 43 sites had some non-insect as the single dominant taxa. These 43 non-insect dominated sites primarily exhibited dominant glide habitat (33 of 43 sites, or 77%). Oligochaete worms were the single dominant taxa at 21 sites. Many Oligochaeta species are known to be pollutant tolerant and are indicative of muddy, fine substrates (Brinkhurst and Gelder 1991). Oligochaeta species were present in all 54 sites ranging from 5.0 to 1094.7 organisms / ft².

Sphaeriidae / Corbiculidae clams were the single dominant taxa at 9 sites. These two bivalve families are difficult to differentiate during early life stages; hence small individuals were grouped. Clams are filter feeders, removing suspended algae, bacteria, and detritus particles from the water column. They are often found in streams and rivers with high levels of turbidity and suspended organic matter, where they burrow in soft substrates. Both families of clams disperse similarly. Upstream movements primarily occur in the larval stage. They clamp on to limbs of insects, feathers of water fowl, limbs of amphibians, or attach to algae or vegetation that tangle on the feet of animals frequenting streams (McMahon 1991). To move downstream, these clams close their shell and let the current roll them downstream. Sphaeriids and the *Corbicula fluminea* (Asian clam) are hermaphroditic, needing only one individual to establish new populations. Although there are many similarities between these clams, *C. fluminea* differ from sphaeriids in many ways. *C. fluminea* are exotic invaders in Oregon, arriving in ballast water of large ships from Asia. They grow much larger than sphaeriids, and can sustain the highest population production rates reported for any bivalve species (McMahon 1991). They inhabit a wide range of conditions, but are less tolerant to cold temperatures than sphaeriids. Also, in contrast to sphaeriids, *C. fluminea* is less tolerant to low oxygen and human disturbance. However *C. fluminea* is an extremely rapid colonizer of denuded habitats. Adult *C. fluminea* were positively identified at 16 sites ranging from 0.1 to 234.0 organisms / ft².

Juga and Hydrobiidae (both in sub-class Prosobranchia) snails were the single dominant taxa at 7 sites. *Juga* are native and fairly ubiquitous in the Pacific Northwest; they are found in streams ranging from the valley floor to the Cascade foothills. They are encountered up to the limits of permanent water in headwater streams. We find them in a wide variety of stream conditions and climate zones, but not in large rivers. They are sometimes associated with in-stream wood (Anderson et al. 1978, Anderson et al. 1984). Like other members of the Pleurocerid snail family, *Juga* prefer algae and diatoms as a food source, but are associated with decomposing leaves in fall and winter (Brown 1991). They may be more abundant in streams with low canopy cover. The long life span of these snails, as much as 4 years, suggests stream stability in habitats where they are found. Hydrobiid snails are also fairly common. These taxa are "gill breathers" and possess an operculum, or "trap door". In contrast to bivalves and pulmonate snails ("air breathers"), prosobranchs do not disperse via other animals (Brown 1991).

Microcrustacea is a broad category of zooplanktonic groups, generally less than a few millimeters in size. They were abundant in many sites. They are commonly found in slow water and soft-bottom/fine substrate habitats of ponds, temporary pools, and streams. Many species in these groups are active swimmers feeding on algae, detritus,

and micro-zooplankton (Dodson and Frey 1991). Because of their size they have difficulties swimming in stream currents, and are susceptible to downstream displacement in strong currents (Dole-Olivier, et al. 2000; Robertson, et al. 1995). These taxa were associated with glide habitats and low-gradient stream reaches.

One major group within the microcrustacea are the Cladocera (such as *Daphnia*, or water fleas). Though single individuals may live only a few days, maybe a month, populations persist through multiple generations per season. They form resting eggs that resist desiccation in the stream or lake bottom, surviving seasonal drying or lack of food. Some cladocerans can produce hemoglobin and tolerate low dissolved oxygen (Dodson and Frey 1991). Cladocerans were present in 21 sites ranging from 0.1 to 1526.5 organisms / ft², and were the single dominant organism at 1 site.

Copepods, another microcrustacean group, are often associated with pond-like habitats, but are common in Willamette Valley streams. They are relatively stronger swimmers compared to Cladocera, and individuals generally live one year. They are likely found in perennial channels. They were present in 36 sites ranging from 0.4 to 518.9 organisms / ft², and were the single dominant organism at 2 sites. Ostracods are bottom-dwelling microcrustacea that have a double-walled shell and protective internal fluid to resist desiccation and freezing (Delorme 1991). They were present in 20 sites ranging from 0.4 to 134.3 organisms / ft², but were not dominant at any site.

Isopods are macroinvertebrates, larger than microcrustacea and comparable to insects in size, and have exposed gills. They occur in constant, cold water and generally require high dissolved oxygen (Covich and Thorp 1991). They are ideal for biomonitoring due to their high sensitivity to toxins, copper, and other heavy metals (Covich and Thorp 1991). They were present in 27 sites ranging from 0.1 to 536.7 organisms / ft². They were the single dominant taxa at 1 site. Sites where they were abundant warrant further study.

Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), often grouped as "EPT's", are commonly used as indicators of stream health. They are important food items for many fish, particularly salmonids. Because they have exposed gills, most EPT's require higher oxygen concentrations than other aquatic invertebrates (Resh and Solem 1996). Many EPT taxa are sensitive to human disturbance and pollution. However, there are a number of taxa that have adapted to live in lower quality aquatic habitats; therefore numerous EPT taxa, rather than singular or few, are indicative of higher water quality. Eight riffle sites and 3 glide sites were dominated by EPT's. A list of the relative abundances and densities of EPT's at each site is given in Appendix V.

Relative to stoneflies, mayflies exhibit adaptations to warmer stream temperatures (Wallace and Anderson 1996) and occur in a variety of flowing and standing water habitats (Edmunds and Waltz 1996). Mayflies are often among the dominant stream invertebrates in west slope Cascade streams (Fraday personal observations). Mayflies were present in 30 sites ranging from 0.1 to 221.6 organisms / ft², but they were the single dominant taxa at only 5 sites (3 reference sites). Representatives of this group indicate a range of stream conditions. Mayflies in the genus *Pseudocloeon* (family Baetidae), were present in 22 sites, and dominant in 3. Nearly all *Pseudocloeon* have

multiple generations per year; they are widely distributed through the Willamette Valley (Gerth personal communication). *Paraleptophlebia* (family Leptophlebiidae) were present in 12 sites and dominant in 1. This genus is found in both slow and fast water (Hilsenhoff 1991). *Cinygma* (family Heptageniidae) mayflies were present in only 6 sites, but dominant in 1. They are usually found in cooler water on coarse substrates or wood. These three genera were the most common mayflies across sites, yet their overall abundance compared to other aquatic invertebrates was low.

Stoneflies (Plecoptera) as a group are among the most sensitive stream insects; they generally lack extensive gills and most species are intolerant to low oxygen concentrations and warmer waters (Hilsenhoff 1991). Many stoneflies have long life cycles. Some depend on decomposing leaves, but many are predatory. They were present in only 9 sites, and dominant in 1. *Zapada* (family Nemouridae) was the dominant taxa at one reference site with a density of 51.4 organisms / ft². *Zapada* and *Sweltsa* (family Chloroperlidae) were present in 5 sites. *Zapada* are shredding invertebrates (that is they shred and consume coarse organic matter), and are commonly found in steep-gradient, headwater streams with substantial inputs of leaf litter. We would expect these shredders to be most evident during the sampling period for this study as it coincides with leaf fall for most deciduous tree species. The low numbers of Plecoptera across sites may indicate unsuitable habitat for these taxa.

Caddisflies (Trichoptera) are widely distributed in lotic (flowing water) habitats and have been somewhat successful in larger, warmer, lentic (standing water) habitats (Wiggins 1996). Most have only one generation per year, and some survive as individuals for 1 1/2 or 2 years in colder climates. They were present at 31 sites ranging 0.1 to 339.8 organisms / ft². However, caddisflies, represented by *Cheumatopsyche* (family Hydropsychidae), were dominant at only 2 sites. *Cheumatopsyche* was the most common caddisfly among Portland metro sites; *Hydropsyche*, also a Hydropsychid, the second most common, was present in 8 sites. Hydropsychid caddisflies build filtering nets on the tops of in-stream rocks and wood to collect bits of organic matter in the water column. They are opportunistic feeders, with species or genus specific tolerances to organic pollution, and are useful indicators in biomonitoring (Hilsenhoff 1991). *Cheumatopsyche*, that we found most numerous in this study, are generally more dominant than *Hydropsyche* in warmer streams (Ross 1959).

Chironomidae or "midges", (order Diptera, true flies) were represented at all sites. This is the largest family of aquatic insects (Hilsenhoff 1991). Roughly 40% of all aquatic insects are in the order Diptera and about one third of these are Chironomids (Hilsenhoff 1991). Given that this family displays a wide range of morphological, physiological, and behavioral adaptations to environmental conditions (Coffman and Ferrington 1996), it is not surprising to find them ubiquitous in these streams. They represent many important links in various food webs. Many species exhibit multiple generations per year, and provide a plentiful energy source for aquatic food chains. They provide an extremely important resource for juvenile predaceous fish, including trout (Coffman and Ferrington 1996). Many chironomid species are tolerant to low levels of oxygen and have a hemoglobin-like pigment that stores oxygen (Hilsenhoff 1991).

Chironomid abundance in Portland metro sites ranged from 3.7 to 833.3 organisms / ft². Three sites had midges as the single dominant taxa. The sub-families Tanypodinae

and Orthocladiinae were present at 52 and 45 sites respectively. Our protocol follows the splitting of the sub-family Chironominae into tribes Chironomini and Tanytarsini. These two tribes were present at 47 and 43 sites respectively. At one site, Tanypodinae was the single most dominant taxa with Tanytarsini a close second. In another site, Tanytarsini was dominant, with Tanypodinae a close second. Orthocladiinae was the single dominant taxa at a third site. A less common sub-family Prodeamesinae was present at 13 sites. Some chironomid species are predators, especially Tanypodinae species, but species are diverse in their feeding modes including collecting particulate organic matter, scraping algae, and filter feeding. In theory, the resource partitioning in this family enhances biotic ecosystem stability (Coffman and Ferrington 1996).

Alderflies, *Sialis* (order Megaloptera) were not present in large numbers at any given site, but were found at 35 sites. They are large, predatory insects that typically burrow into soft-substrates as aquatic larvae (Evans and Neunzig 1996). Their tolerance to low oxygen levels is enhanced by long posterior filaments that increase their abdominal surface area for oxygen uptake (Hilsenhoff 1991). They are associated with riparian trees in their adult phase.

Another commonly found group was aquatic mites that play an important role in ecosystem linkages. Hydracarina species were present at 48 sites. They parasitize 20 – 50% of adult flying insects (Smith and Cook 1991) which dramatically increases their dispersal potential. They are difficult to identify and are often disregarded and underestimated. This may lead to inaccurate community studies (Smith and Cook 1991). Many studies have shown that water mites are excellent indicators of habitat quality and diversity is greatly reduced in disturbed or degraded habitat. Even though water mites were present at 48 sites, their overall abundance was quite low.

Appendix III: Individual B-IBI scores for each site

site - AL01 date - 9/3/2001		site - AL02 date - 9/5/2001		site - AL03 date - 9/19/2001		site - AL04 date - 9/19/2001	
Hazeldale Park / Rosa Park Butternut Creek, Aloha		Meadowbrook Park / Stoddard Park / Butternut Creek Elementary School Butternut Creek, Aloha		Aloha / Pheasant Park Beaverton Creek, Aloha		Stonecrest Park / Cain Park / Summercrest Park Johnson Creek, Beaverton	
metric	ODEQ B-IBI	score	PS B-IBI	metric	ODEQ B-IBI	score	PS B-IBI
taxa richness	25	3	20	3	23	3	21
mayfly richness	0	1	0	1	1	1	1
stonefly richness	0	1	0	1	0	1	1
caddisfly richness	1	1	1	1	0	1	0
sensitive taxa	0	1	N/A	N/A	0	1	N/A
sediment sensitive taxa	0	1	N/A	N/A	0	1	N/A
modified HBI	7.3	1	N/A	N/A	7.2	1	N/A
% tolerant taxa	10.4	5	2.5	5	30.5	3	19.8
% sediment tolerant taxa	6.9	5	N/A	N/A	21.1	3	N/A
% dominant (single taxa)	28.3	3	N/A	N/A	16.9	5	N/A
long-lived taxa	N/A	N/A	1	N/A	N/A	3	1
intolerant taxa	N/A	0	1	N/A	N/A	0	1
clinger taxa	N/A	1	1	N/A	N/A	0	1
% predators	N/A	2.2	1	N/A	N/A	5.3	3
% dominant (three taxa)	N/A	65.7	3	N/A	N/A	46.4	5
total score		22	18		20	22	16
site - BE01 date - 9/25/2001		site - BE02 date - 9/4/2001		site - BE03 date - 9/4/2001		site - BE04 date - 9/5/2001	
Carlin Homeowners Aloha		Murrayhill Homeowners Summer Creek, Cooper Mountain		Murphyhill Homeowners Summer Creek, Cooper Mountain		Murrayhill Homeowners Summer Creek, Cooper Mountain	
metric	ODEQ B-IBI	score	PS B-IBI	metric	ODEQ B-IBI	score	PS B-IBI
taxa richness	26	3	21	3	23	3	21
mayfly richness	1	1	1	2	1	2	1
stonefly richness	0	1	0	1	0	1	0
caddisfly richness	2	1	2	1	3	3	N/A
sensitive taxa	0	1	N/A	N/A	1	N/A	N/A
sediment sensitive taxa	0	1	N/A	N/A	0	1	N/A
modified HBI	6.5	1	N/A	N/A	5.2	1	N/A
% tolerant taxa	21.8	3	5.3	5	21.2	3	8.6
% sediment tolerant taxa	15.2	3	N/A	N/A	12.6	3	N/A
% dominant (single taxa)	31.9	3	N/A	N/A	17.3	5	N/A
long-lived taxa	N/A	1	1	N/A	N/A	1	1
intolerant taxa	N/A	0	1	N/A	N/A	1	1
clinger taxa	N/A	1	1	N/A	N/A	4	1
% predators	N/A	3.7	1	N/A	N/A	5.5	3
% dominant (three taxa)	N/A	68.3	3	N/A	N/A	37.2	5
total score		18	18		20	24	20

Appendix III (cont.): Individual B-IBI scores for each site

site - BE03
date - 9/12/2001
Public Utility / Hunters Woods HOA
Willow Creek, Cedar Mill

site - BE04
date - 9/25/2001
Tualatin Hills Nature Park
Cedar Johnson Creek, Beaverton

metric	ODEQ B-IBI	score	PS B-IBI	score	ODEQ B-IBI	score	PS B-IBI	score
taxa richness	15	1	12	1	10	1	8	1
mayfly richness	0	1	0	1	0	1	0	1
stonefly richness	0	1	0	1	0	1	0	1
caddisfly richness	0	1	0	1	0	1	0	1
sensitive taxa	0	1	N/A	N/A	0	1	0	1
sediment sensitive taxa	0	1	N/A	N/A	0	1	N/A	N/A
modified HBI	6.7	1	N/A	N/A	6	1	N/A	N/A
% tolerant taxa	38.9	3	3.4	5	87.9	1	0	5
% sediment tolerant taxa	37.5	1	N/A	N/A	86	1	N/A	N/A
% dominant (single taxa)	34.5	3	N/A	N/A	86	1	N/A	N/A
long-lived taxa	N/A	N/A	3	1	N/A	0	1	1
intolerant taxa	N/A	0	1	1	N/A	0	1	1
clinger taxa	N/A	1	1	1	N/A	0	1	1
% predators	N/A	1.3	1	1	N/A	2.6	1	1
% dominant (three taxa)	N/A	79.3	1	1	N/A	92.9	1	1
total score			14			10		14

metric	ODEQ B-IBI	score	PS B-IBI	score	ODEQ B-IBI	score	PS B-IBI	score
taxa richness	30	3	27	3	12	1	11	1
mayfly richness	2	1	2	1	0	1	0	1
stonefly richness	0	1	0	1	0	1	0	1
caddisfly richness	3	1	3	3	0	1	0	1
sensitive taxa	0	1	N/A	N/A	0	1	N/A	N/A
sediment sensitive taxa	0	1	N/A	N/A	0	1	N/A	N/A
modified HBI	7.6	1	N/A	N/A	8.1	1	N/A	N/A
% intolerant taxa	16.9	3	10.8	5	30.5	3	4.6	5
% sediment tolerant taxa	14.2	3	N/A	N/A	22.2	3	N/A	N/A
% dominant (single taxa)	60.2	1	N/A	N/A	66.4	1	N/A	N/A
long-lived taxa	N/A	3	1	1	N/A	1	1	1
intolerant taxa	N/A	0	1	1	N/A	0	1	1
clinger taxa	N/A	3	1	1	N/A	0	1	1
% predators	N/A	2	1	1	N/A	0.9	1	1
% dominant (three taxa)	N/A	77.5	1	1	N/A	93.1	1	1
total score			16			18		14

metric	ODEQ B-IBI	score	PS B-IBI	score	ODEQ B-IBI	score	PS B-IBI	score
taxa richness						19	3	16
mayfly richness						1	1	1
stonefly richness						0	1	0
caddisfly richness						1	1	1
sensitive taxa						0	1	1
sediment sensitive taxa						0	1	1
modified HBI						5.5	1	1
% tolerant taxa						38.9	3	36.3
% sediment tolerant taxa						4.2	5	5
% dominant (single taxa)						33.5	3	3
long-lived taxa						N/A	N/A	N/A
intolerant taxa						N/A	N/A	N/A
clinger taxa						N/A	N/A	N/A
% predators						N/A	N/A	N/A
% dominant (three taxa)						N/A	N/A	N/A
total score								

metric	ODEQ B-IBI	score	PS B-IBI	score	ODEQ B-IBI	score	PS B-IBI	score
taxa richness						15	1	13
mayfly richness						0	1	0
stonefly richness						0	1	0
caddisfly richness						1	1	1
sensitive taxa						0	1	1
sediment sensitive taxa						0	1	1
modified HBI						6	1	1
% tolerant taxa						80.7	1	3.2
% sediment tolerant taxa						77.8	1	5
% dominant (single taxa)						77.6	1	N/A
long-lived taxa						N/A	N/A	N/A
intolerant taxa						N/A	N/A	2
clinger taxa						N/A	N/A	1
% predators						N/A	N/A	2
% dominant (three taxa)						N/A	N/A	1
total score								

Appendix III (cont.): Individual B-IBI scores for each site

site - GR01 Kane Road Neighborhood Park Kelly Creek, Gresham		site - GR02 date - 8/27/2001		Main City Park / Gresham Pioneer Cemetery / Springwater Corridor Johnson Creek, Gresham		site - GR03 date - 8/27/2001		Hogan Road / Springwater Corr. Johnson Creek, Gresham			
metric	ODEQ B-IBI score	PS B-IBI score	metric	ODEQ B-IBI score	PS B-IBI score	metric	ODEQ B-IBI score	PS B-IBI score	metric	ODEQ B-IBI score	PS B-IBI score
taxa richness	15	1	12	1	24	3	21	3	28	3	25
mayfly richness	0	1	0	1	3	1	3	1	3	1	3
stonefly richness	0	1	0	1	0	1	0	1	0	1	0
caddisfly richness	1	1	1	1	2	1	2	1	3	1	3
sensitive taxa	0	1	N/A	N/A	1	1	N/A	N/A	0	1	N/A
sediment sensitive taxa	0	1	N/A	N/A	0	1	N/A	N/A	1	3	N/A
modified HBI	6.6	1	N/A	N/A	5.6	1	N/A	N/A	5.7	1	N/A
% tolerant taxa	57.6	1	6.7	5	29.8	3	26.7	5	48.8	1	44.2
% sediment tolerant taxa	45.1	1	N/A	N/A	29.1	1	N/A	N/A	20.4	3	N/A
% dominant (single taxa)	45.1	1	N/A	N/A	% dominant (single taxa)	16.1	5	N/A	% dominant (single taxa)	19.5	5
long-lived taxa	N/A	N/A	1	1	N/A	N/A	3	1	long-lived taxa	N/A	5
intolerant taxa	N/A	0	1	1	N/A	N/A	1	1	intolerant taxa	N/A	3
clinger taxa	N/A	0	1	1	N/A	N/A	5	1	clinger taxa	N/A	0
% predators	N/A	7.3	3	3	N/A	N/A	0.8	1	% predators	N/A	6
% dominant (three taxa)	N/A	71.1	3	N/A	N/A	41.4	5	% dominant (three taxa)	N/A	N/A	0.6
total score			10		18		18		total score		51.5
											5
site - GR04 Butler Creek Open Space Jenne Creek, Gresham		site - GR05 date - 9/3/2001		Springwater Corridor Johnson Creek, Gresham		site - GR06 date - 9/3/2001		North of Butler Creek site Jenne Creek, Gresham			
metric	ODEQ B-IBI score	PS B-IBI score	metric	ODEQ B-IBI score	PS B-IBI score	metric	ODEQ B-IBI score	PS B-IBI score	metric	ODEQ B-IBI score	PS B-IBI score
taxa richness	26	3	22	3	17	1	14	3	taxa richness	21	3
mayfly richness	2	1	2	1	2	1	2	1	mayfly richness	1	1
stonefly richness	0	1	0	1	0	1	0	1	stonefly richness	0	1
caddisfly richness	0	1	0	1	1	1	1	1	caddisfly richness	1	1
sensitive taxa	0	1	N/A	N/A	0	1	N/A	N/A	sensitive taxa	0	N/A
sediment sensitive taxa	0	1	N/A	N/A	0	1	N/A	N/A	sediment sensitive taxa	0	N/A
modified HBI	6.9	1	N/A	N/A	5.7	1	N/A	N/A	modified HBI	5.4	1
% tolerant taxa	43.6	3	22.5	5	% tolerant taxa	57.6	1	49.1	% tolerant taxa	35.8	3
% sediment tolerant taxa	20.3	3	N/A	N/A	% sediment tolerant taxa	38.7	1	N/A	% sediment tolerant taxa	32	1
% dominant (single taxa)	22.6	3	N/A	N/A	% dominant (single taxa)	24.5	3	N/A	% dominant (single taxa)	39.6	3
long-lived taxa	N/A	3	1	1	N/A	N/A	3	1	long-lived taxa	N/A	2
intolerant taxa	N/A	0	1	1	N/A	N/A	0	1	intolerant taxa	N/A	1
clinger taxa	N/A	2	1	1	N/A	N/A	2	1	clinger taxa	N/A	2
% predators	N/A	1.4	1	1	N/A	N/A	0.3	1	% predators	N/A	0.2
% dominant (three taxa)	N/A	55.8	3	N/A	N/A	59	3	% dominant (three taxa)	N/A	N/A	
total score			18		18		18		total score		14
											16
											16

Appendix III (cont.): Individual B-IBI scores for each site

site - HB02 Bethany Lake Park Rock Creek, Bethany		site - HB03 date - 9/24/2001		Rock Creek Greenway Rock Creek, Merle		site - HB04 Willow Creek Nature Park / Mushofsky Park Stonegate Phase III Park		site - HB05 date - 9/13/2001		Willow Creek, Marlene Village			
metric	ODEQ B-IBI	score	PS B-IBI	score	ODEQ B-IBI	score	PS B-IBI	score	ODEQ B-IBI	score	PS B-IBI	score	
taxa richness	17	1	16	3	taxa richness	19	3	16	3	taxa richness	17	1	14
mayfly richness	0	1	0	1	mayfly richness	0	1	0	1	mayfly richness	0	1	0
stonefly richness	0	1	0	1	stonefly richness	0	1	0	1	stonefly richness	0	1	0
caddisfly richness	0	1	0	1	caddisfly richness	0	1	0	1	caddisfly richness	0	1	0
sensitive taxa	0	1	N/A	N/A	sensitive taxa	0	1	N/A	N/A	sensitive taxa	0	1	N/A
sediment sensitive taxa	0	1	N/A	N/A	sediment sensitive taxa	0	1	N/A	N/A	sediment sensitive taxa	0	1	N/A
modified HBI	6.5	1	N/A	N/A	modified HBI	6.9	1	N/A	N/A	modified HBI	5.8	1	N/A
% tolerant taxa	64.7	1	7.1	5	% tolerant taxa	25.6	3	3.5	5	% tolerant taxa	38.2	3	10.5
% sediment tolerant taxa	61	1	N/A	N/A	% sediment tolerant taxa	25	3	N/A	N/A	% sediment tolerant taxa	36.6	1	N/A
% dominant (single taxa)	54.9	1	N/A	N/A	% dominant (single taxa)	30	3	N/A	N/A	% dominant (single taxa)	48.5	1	N/A
long-lived taxa	N/A	2	1	N/A	long-lived taxa	N/A	2	1	N/A	long-lived taxa	N/A	2	1
intolerant taxa	N/A	0	1	N/A	intolerant taxa	N/A	0	1	N/A	intolerant taxa	N/A	0	1
clinger taxa	N/A	0	1	N/A	clinger taxa	N/A	0	1	N/A	clinger taxa	N/A	0	1
% predators	N/A	1.1	1	N/A	% predators	N/A	0.6	1	N/A	% predators	N/A	1.1	1
% dominant (three taxa)	N/A	72.4	3	N/A	% dominant (three taxa)	N/A	69.6	3	N/A	% dominant (three taxa)	N/A	85	1
total score		10	18		total score	18		18		total score	12	16	

site - HB06 Honeywood Park / Chantal Village Park / Arleda's Park / Willow Creek West Beaverton Creek, Aloha		site - HB07 Hamby Park / Jackson School North Hillsboro											
metric	ODEQ B-IBI	score	PS B-IBI	metric	ODEQ B-IBI	score	PS B-IBI	score					
taxa richness	21	3	19	3	taxa richness	16	1	15	3	taxa richness	26	3	23
mayfly richness	1	1	1	1	mayfly richness	0	1	0	1	mayfly richness	0	1	0
stonefly richness	0	1	0	1	stonefly richness	0	1	0	1	stonefly richness	0	1	0
caddisfly richness	0	1	0	1	caddisfly richness	0	1	0	1	caddisfly richness	0	1	0
sensitive taxa	1	1	N/A	N/A	sensitive taxa	0	1	N/A	N/A	sensitive taxa	0	1	N/A
sediment sensitive taxa	0	1	N/A	N/A	sediment sensitive taxa	0	1	N/A	N/A	sediment sensitive taxa	0	1	N/A
modified HBI	6.6	1	N/A	N/A	modified HBI	6.8	1	N/A	N/A	modified HBI	7.6	1	N/A
% tolerant taxa	66.9	1	11.3	5	% tolerant taxa	88.1	1	0.5	5	% tolerant taxa	80.2	1	18.4
% sediment tolerant taxa	42.4	1	N/A	N/A	% sediment tolerant taxa	87.4	1	N/A	N/A	% sediment tolerant taxa	13.6	3	N/A
% dominant (single taxa)	37.4	3	N/A	N/A	% dominant (single taxa)	62.7	1	N/A	N/A	% dominant (single taxa)	55.2	1	N/A
long-lived taxa	N/A	4	3	N/A	long-lived taxa	N/A	2	1	N/A	long-lived taxa	N/A	4	3
intolerant taxa	N/A	0	1	N/A	intolerant taxa	N/A	0	1	N/A	intolerant taxa	N/A	1	1
clinger taxa	N/A	0	1	N/A	clinger taxa	N/A	0	1	N/A	clinger taxa	N/A	0	1
% predators	N/A	2.2	1	N/A	% predators	N/A	3.3	1	N/A	% predators	N/A	4.1	1
% dominant (three taxa)	N/A	64.6	3	N/A	% dominant (three taxa)	N/A	90.8	1	N/A	% dominant (three taxa)	N/A	71.8	3
total score		14	20		total score	10		16		total score	14	20	

Appendix III (cont.): Individual B-IBI scores for each site

site • HB08
date - 9/13/2001
Bethany Meadows Park / Springville
Meadows Park / Ben Graf Meadows Park

site • HB10
date - 9/24/2001
Noziger Property / Upper Rock Creek
Open Space
Rock Creek, Merle

metric	ODEQ B-IBI	score	PS B-IBI	score
taxa richness	26	3	22	3
mayfly richness	0	1	0	1
stonefly richness	0	1	0	1
caddisfly richness	1	1	1	1
sensitive taxa	0	1	N/A	N/A
sediment sensitive taxa	0	1	N/A	N/A
modified HBI	6.7	1	N/A	N/A
% tolerant taxa	29.1	3	8.7	5
% sediment tolerant taxa	20.7	3	N/A	N/A
% dominant (single taxa)	20.2	3	N/A	N/A
long-lived taxa	N/A	1	1	1
intolerant taxa	N/A	0	1	1
clinger taxa	N/A	1	0	1
% predators	N/A	2.4	1	3
% dominant (three taxa)	N/A	55.1	3	5
total score		18		18

site • HB11
date - 9/13/2001
Salix Park
Willow Creek, Elmonica

metric	ODEQ B-IBI	score	PS B-IBI	score
taxa richness			23	3
mayfly richness			1	1
stonefly richness			0	1
caddisfly richness			0	1
sensitive taxa			0	1
sediment sensitive taxa			0	1
modified HBI			0	1
% tolerant taxa			12.9	5
% sediment tolerant taxa			33.3	1
% dominant (single taxa)			18.9	5
long-lived taxa			N/A	N/A
intolerant taxa			N/A	N/A
clinger taxa			N/A	N/A
% predators			N/A	N/A
% dominant (three taxa)			N/A	N/A
total score		16		22

site • HB12
date - 9/25/2001
Deerfield Park
Bethany

site • HB13
date - 9/25/2001
Valley Memorial Park Cemetery
Rock Creek, Newton

site • HB14
date - 8/30/2001
Middle Rock Cr. Open Space / Dawson Cr.
Properties / Creekside
Rock Creek, Orenco

metric	ODEQ B-IBI	score	PS B-IBI	score
taxa richness	25	3	22	3
mayfly richness	0	1	0	1
stonefly richness	0	1	0	1
caddisfly richness	0	1	0	1
sensitive taxa	0	1	N/A	N/A
sediment sensitive taxa	0	1	N/A	N/A
modified HBI	6.4	1	N/A	N/A
% tolerant taxa	61.8	1	18.8	5
% sediment tolerant taxa	N/A	1	N/A	N/A
% dominant (single taxa)	40.7	1	N/A	N/A
long-lived taxa	N/A	1	1	1
intolerant taxa	N/A	0	1	1
clinger taxa	N/A	0	1	1
% predators	N/A	1.4	1	1
% dominant (three taxa)	N/A	53.8	5	3
total score		12		20

metric	ODEQ B-IBI	score	PS B-IBI	score
taxa richness			19	3
mayfly richness			0	1
stonefly richness			0	1
caddisfly richness			0	1
sensitive taxa			0	1
sediment sensitive taxa			N/A	N/A
modified HBI			0	1
% tolerant taxa			7.5	1
% sediment tolerant taxa			35.3	3
% dominant (single taxa)			33.3	1
long-lived taxa			N/A	N/A
intolerant taxa			N/A	N/A
clinger taxa			N/A	N/A
% predators			N/A	N/A
% dominant (three taxa)			N/A	N/A
total score		14		16

Appendix III (cont.): Individual B-IBI scores for each site

site - LO01
date - 10/2/2001

Bryant Woods Park (Private)
Lake Oswego

site - M101
date - 8/24/2001

North Clackamas Central Park
Kelllogg Creek, Milwaukie

site - MCCR
date - 10/1/2001

McKay Creek Reference Site
McKay Creek, Shadybrook

metric	ODEQ B-IBI	score	PS B-IBI	score
taxa richness	18	1	16	3
mayfly richness	0	1	0	1
stonefly richness	0	1	0	1
caddisfly richness	0	1	0	1
sensitive taxa	1	1	NA	NA
sediment sensitive taxa	0	1	NA	NA
modified HBI	7.1	1	NA	NA
% tolerant taxa	26.1	3	6.1	5
% sediment tolerant taxa	24.3	3	NA	NA
% dominant (single taxa)	44.5	1	NA	NA
long-lived taxa	NA	NA	3	1
intolerant taxa	NA	0	1	1
clinger taxa	NA	0	NA	NA
% predators	NA	1.5	1	1
% dominant (three taxa)	NA	79.2	1	NA
total score		14	16	16

site - P001
date - 8/28/2001

Marshall Park
Tryon Creek, Englewood / Lake Oswego

site - M101
date - 8/24/2001

North Clackamas Central Park
Kelllogg Creek, Milwaukie

site - MCCR
date - 10/1/2001

McKay Creek Reference Site
McKay Creek, Shadybrook

site - P002
date - 10/12/2001

Tryon Creek State Park South
Tryon Creek, Englewood / Lake Oswego

site - P003
date - 10/1/2001

Tryon Creek State Park North
Tryon Creek, Englewood / Lake Oswego

metric	ODEQ B-IBI	score	PS B-IBI	score
taxa richness	20	3	18	3
mayfly richness	1	1	1	1
stonefly richness	0	1	0	1
caddisfly richness	3	1	3	3
sensitive taxa	0	1	NA	NA
sediment sensitive taxa	0	1	NA	NA
modified HBI	5.4	1	NA	NA
% tolerant taxa	30.2	3	15.2	5
% sediment tolerant taxa	13.3	3	NA	NA
% dominant (single taxa)	21.7	3	NA	NA
long-lived taxa	NA	1	1	1
intolerant taxa	NA	0	1	1
clinger taxa	NA	2	1	1
% predators	NA	2.4	1	1
% dominant (three taxa)	NA	49.8	5	NA
total score		18	22	22

metric	ODEQ B-IBI	score	PS B-IBI	score
taxa richness	31	3	28	3
mayfly richness	3	1	3	1
stonefly richness	1	1	1	1
caddisfly richness	3	1	3	3
sensitive taxa	0	1	NA	NA
sediment sensitive taxa	0	1	NA	NA
modified HBI	5.1	1	NA	NA
% tolerant taxa	55.4	1	3	5
% sediment tolerant taxa	39.6	1	NA	NA
% dominant (single taxa)	36.9	3	NA	NA
long-lived taxa	NA	4	3	3
intolerant taxa	NA	2	3	2
clinger taxa	NA	5	1	1
% predators	NA	0.9	1	1
% dominant (three taxa)	NA	61.3	3	NA
total score		16	24	24

Appendix III (cont.): Individual B-IBI scores for each site

site - PO08
date - 9/19/2001
Jordan Park
Mill Creek, Bonny Slope

site - PO10
date - 10/3/2001
Balch Creek / Audubon Sanctuary
Balch Creek, Willamette Heights

metric	ODEQ B-IBI	score	PS B-IBI	score
taxa richness	17	1	14	3
mayfly richness	2	1	2	1
stonefly richness	0	1	0	1
caddisfly richness	1	1	1	1
sensitive taxa	0	1	N/A	N/A
sediment sensitive taxa	0	1	N/A	N/A
modified HBI	5.3	1	N/A	N/A
% tolerant taxa	19.4	3	18	5
% sediment tolerant taxa	1.6	5	N/A	N/A
% dominant (single taxa)	19.1	5	N/A	N/A
long-lived taxa	N/A	1	1	1
intolerant taxa	N/A	0	1	1
clinger taxa	N/A	3	N/A	N/A
% predators	N/A	1.8	1	1
% dominant (three taxa)	N/A	52.3	5	5
total score		20	20	20

site - PO12
date - 10/3/2001
Saltzman / Forest Park New Site
Willbridge

site - PR01
date - 9/18/2001
Fanno Creek Park
Fanno Creek, Progress

metric	ODEQ B-IBI	score	PS B-IBI	score
taxa richness	47	5	45	5
mayfly richness	6	3	6	3
stonefly richness	6	5	6	5
caddisfly richness	7	3	7	5
sensitive taxa	4	3	N/A	N/A
sediment sensitive taxa	2	5	N/A	N/A
modified HBI	3.4	5	N/A	N/A
% tolerant taxa	12.8	5	8.2	5
% sediment tolerant taxa	12.5	3	N/A	N/A
% dominant (single taxa)	19.9	5	N/A	N/A
long-lived taxa	N/A	7	3	5
intolerant taxa	N/A	5	5	5
clinger taxa	N/A	8	3	3
% predators	N/A	12.8	5	5
% dominant (three taxa)	N/A	33.4	5	5
total score		42	44	44

site - PO11
date - 10/2/2001
Balch Creek / Lower Madeay Park
Balch Creek, Willamette Heights

site - SH02
date - 9/6/2001
Public Park
Cedar Creek, Sherwood

metric	ODEQ B-IBI	score	PS B-IBI	score
taxa richness	34	3	32	5
mayfly richness	4	3	4	3
stonefly richness	4	3	3	3
caddisfly richness	5	3	5	3
sensitive taxa	1	1	N/A	N/A
sediment sensitive taxa	2	5	N/A	N/A
modified HBI	4.3	3	N/A	N/A
% tolerant taxa	31.7	3	24.5	5
% sediment tolerant taxa	26.7	1	N/A	N/A
% dominant (single taxa)	23.9	3	N/A	N/A
long-lived taxa	N/A	5	3	3
intolerant taxa	N/A	2	3	3
clinger taxa	N/A	8	3	3
% predators	N/A	12.1	5	5
% dominant (three taxa)	N/A	43.6	5	5
total score		28	38	38

site - PO11
date - 10/2/2001
Balch Creek / Lower Madeay Park
Balch Creek, Willamette Heights

metric	ODEQ B-IBI	score	PS B-IBI	score
taxa richness	15	1	14	3
mayfly richness	0	1	0	1
stonefly richness	0	1	0	1
caddisfly richness	0	1	0	1
sensitive taxa	0	1	N/A	N/A
sediment sensitive taxa	0	1	N/A	N/A
modified HBI	7.4	1	N/A	N/A
% tolerant taxa	6.7	5	0.9	5
% sediment tolerant taxa	4.9	5	N/A	N/A
% dominant (single taxa)	34.5	3	N/A	N/A
long-lived taxa	N/A	2	1	1
intolerant taxa	N/A	0	1	1
clinger taxa	N/A	0	1	1
% predators	N/A	2.1	1	1
% dominant (three taxa)	N/A	74.3	3	3
total score		32	32	32

Appendix III (cont.): Individual B-IBI scores for each site

site - T101 Englewood Park
date - 9/5/2001 Greenburg

metric	OSEQ B-IBI	score	PS B-IBI	score
taxa richness	17	1	15	3
mayfly richness	0	1	0	1
stonefly richness	0	1	0	1
caddisfly richness	0	1	0	1
sensitive taxa	0	1	N/A	N/A
sediment sensitive taxa	0	1	N/A	N/A
modified HBI	7.8	1	N/A	N/A
% tolerant taxa	24	3	6.9	5
% sediment tolerant taxa	19.4	3	N/A	N/A
% dominant (single taxa)	41.9	1	N/A	N/A
long-lived taxa	N/A	2	1	N/A
intolerant taxa	N/A	0	1	N/A
clinger taxa	N/A	0	1	N/A
% predators	N/A	0.6	1	N/A
% dominant (three taxa)	N/A	72.8	3	N/A
total score		14	18	18

site - T102 Fanno Creek Park
date - 9/18/2001 Fanno Creek, Tigard

metric	OSEQ B-IBI	score	PS B-IBI	score
taxa richness	17	1	15	3
mayfly richness	0	1	0	1
stonefly richness	0	1	0	1
caddisfly richness	0	1	0	1
sensitive taxa	0	1	N/A	N/A
sediment sensitive taxa	0	1	N/A	N/A
modified HBI	6.1	1	N/A	N/A
% tolerant taxa	67.7	1	5.9	5
% sediment tolerant taxa	63.5	1	N/A	N/A
% dominant (single taxa)	58	1	N/A	N/A
long-lived taxa	N/A	3	1	N/A
intolerant taxa	N/A	0	1	N/A
clinger taxa	N/A	2	1	N/A
% predators	N/A	0	1	N/A
% dominant (three taxa)	N/A	71.1	3	N/A
total score		12	12	18

site - T104 Lowery Open Space / Woodard Park
date - 9/6/2001 Fanno Creek, Tigard

metric	OSEQ B-IBI	score	PS B-IBI	score
taxa richness	20	3	17	3
mayfly richness	1	1	1	1
stonefly richness	0	1	0	1
caddisfly richness	1	1	1	1
sensitive taxa	0	1	N/A	N/A
sediment sensitive taxa	0	1	N/A	N/A
modified HBI	6.1	1	N/A	N/A
% tolerant taxa	42.1	3	29	3
% sediment tolerant taxa	27.9	1	N/A	N/A
% dominant (single taxa)	27.3	3	N/A	N/A
long-lived taxa	N/A	3	1	N/A
intolerant taxa	N/A	0	1	N/A
clinger taxa	N/A	2	1	N/A
% predators	N/A	0.7	1	N/A
% dominant (three taxa)	N/A	50.5	5	N/A
total score		16	16	18

site - T107 Greenway Park
date - 9/20/2001 Fanno Creek, Tigard

metric	OSEQ B-IBI	score	PS B-IBI	score
taxa richness	16	1	13	1
mayfly richness	1	1	1	1
stonefly richness	0	1	0	1
caddisfly richness	0	1	1	1
sensitive taxa	0	1	N/A	N/A
sediment sensitive taxa	0	1	N/A	N/A
modified HBI	6.2	1	N/A	N/A
% tolerant taxa	51.7	1	40.3	3
% sediment tolerant taxa	51.1	1	N/A	N/A
% dominant (single taxa)	37.7	3	N/A	N/A
long-lived taxa	N/A	2	1	N/A
intolerant taxa	N/A	0	1	N/A
clinger taxa	N/A	2	1	N/A
% predators	N/A	1.3	1	N/A
% dominant (three taxa)	N/A	63.1	3	N/A
total score		12	12	14

site - T108 Creekside Park / Holly Tree Terrace Trails /
date - 9/21/2001 Genesis # 3
Tigard

metric	OSEQ B-IBI	score	PS B-IBI	score
taxa richness	14	1	12	1
mayfly richness	0	1	0	1
stonefly richness	0	1	0	1
caddisfly richness	0	1	0	1
sensitive taxa	0	1	N/A	N/A
sediment sensitive taxa	0	1	N/A	N/A
modified HBI	6.7	1	N/A	N/A
% tolerant taxa	69.7	1	28.6	3
% sediment tolerant taxa	69.3	1	N/A	N/A
% dominant (single taxa)	40.7	1	N/A	N/A
long-lived taxa	N/A	3	1	N/A
intolerant taxa	N/A	0	1	N/A
clinger taxa	N/A	0	1	N/A
% predators	N/A	2.3	1	N/A
% dominant (three taxa)	N/A	82	1	N/A
total score		10	12	12

Appendix III (cont.): Individual B-IBI scores for each site

site - Ti08 Copper Creek Greenway
date - 9/20/2001 Copper Creek, Tigard

site - Wl01 Oxbow Park near Sandy River
date - 10/22/2001 Gordon Creek, Troutdale

site - Wl01 New Parks (Private - enter on Valhalos Dr)
date - 9/17/2001 Boeckman Creek, Wilsonville

metric	ODEQ B-IBI	score	PS B-IBI	score	ODEQ B-IBI	score	PS B-IBI	score
taxa richness	20	3	16	3				
mayfly richness	0	1	0	1				
stonefly richness	1	1	1	1				
caddisfly richness	1	1	1	1				
sensitive taxa	0	1	N/A	N/A				
sediment sensitive taxa	0	1	N/A	N/A				
modified HBI	5.9	1	N/A	N/A				
% tolerant taxa	66.2	1	25.1	5				
% sediment tolerant taxa	46.5	1	N/A	N/A				
% dominant (single taxa)	46.1	1	N/A	N/A				
long-lived taxa		N/A	1	1				
intolerant taxa		N/A	0	1				
clinger taxa		N/A	1	1				
% predators		N/A	0.2	1				
% dominant (three taxa)		N/A	74	3				
total score			12	18				

total score 12 18

site - Wl02 Memorial Park
date - 9/17/2001 Boeckman Creek, Wilsonville

site - Wl02 Palomino Park / Hidden Springs Open Space
date - 9/10/2001 West Linn

site - Wl02 Renaissance Open Space / Sahalee -
IIIahee Park
West Linn

metric	ODEQ B-IBI	score	ODEQ B-IBI	score	PS B-IBI	score	ODEQ B-IBI	score	PS B-IBI	score
taxa richness	18	1	16	3						
mayfly richness	1	1	1	1						
stonefly richness	0	1	0	1						
caddisfly richness	1	1	1	1						
sensitive taxa	0	1	N/A	N/A						
sediment sensitive taxa	0	1	N/A	N/A						
modified HBI	7.3	1	N/A	N/A						
% tolerant taxa	48.8	1	36.2	3						
% sediment tolerant taxa	45.5	1	N/A	N/A						
% dominant (single taxa)	37.6	3	N/A	N/A						
long-lived taxa		N/A	2	1						
intolerant taxa		N/A	0	1						
clinger taxa		N/A	2	1						
% predators		N/A	2.3	1						
% dominant (three taxa)		N/A	82.4	1						
total score			12	14						

total score 12 14

metric	ODEQ B-IBI	score	ODEQ B-IBI	score	PS B-IBI	score	ODEQ B-IBI	score	PS B-IBI	score
taxa richness										
mayfly richness										
stonefly richness										
caddisfly richness										
sensitive taxa										
sediment sensitive taxa										
modified HBI										
% tolerant taxa										
% sediment tolerant taxa										
% dominant (single taxa)										
long-lived taxa										
intolerant taxa										
clinger taxa										
% predators										
% dominant (three taxa)										
total score			12	14						

total score 12 14

Appendix IV: Relative abundances and densities of all invertebrate taxa

site - AL01
date - 9/3/2001
glide

Hazeldale Park / Rosa Park
Butternut Creek, Aloha

site - AL02
date - 9/5/2001
glide

Meadowbrook Park / Stoddard Park /
Butternut Creek Elementary School
Butternut Creek, Aloha

taxa	family	order	relative abundances	densities (# / ft ²)	
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae	Corbiculidae	28.26%	115.62	
Tanytarsinae	Chironomidae	Diptera	23.94%	97.97	Oligochaeta sp.
Ostracoda sp.	Ostracoda sp.	Ostracoda sp.	13.49%	55.18	Copepoda sp.
Chironomini	Chironomidae	Diptera	8.07%	33.03	Cladocera sp.
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	5.78%	23.65	Chironomidae
Tanytarsini	Chironomidae	Diptera	4.77%	19.52	Sphaeridae / Corbiculidae
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	3.94%	16.14	Hyalella
Physidae sp.	Physidae	Pulmonata	1.65%	6.76	Tanypodinae
Chironomidae sp.	Chironomidae	Diptera	1.56%	6.38	Physidae sp.
Stellis	Stellidae	Megaloptera	1.19%	4.88	Lymnaeidae sp.
Orthocladiinae	Chironomidae	Diptera	0.92%	3.75	Gammarus
Copepoda sp.	Copepoda sp.	Copepoda sp.	0.83%	3.38	Seromyia
Chironomidae sp. Pupae	Chironomidae	Diptera	0.73%	3.00	Amphipoda sp.
Isopoda sp.	Isopoda sp.	Isopoda sp.	0.73%	3.00	Coenegerion / Enallagma
Lymnaeidae	Lymnaeidae	Pulmonata	0.73%	3.00	Conixidae sp.
Probezzia	Ceratopogonidae	Diptera	0.73%	3.00	Corbiculidae
Cladocera sp.	Cladocera sp.	Cladocera sp.	0.55%	2.25	Orthocladiinae
Nematoidea sp.	Nematoidea sp.	Nematoda sp.	0.37%	1.50	Sialis
Prodeomesinae	Chironomidae	Diptera	0.37%	1.50	Cailliatellus
Dixella	Dixidae	Diptera	0.28%	1.13	Hirudinea sp.
Dicranota	Tipulidae	Diptera	0.18%	0.75	Hydracarina sp.
Diptera sp. Pupae	Diptera sp.	Diptera	0.18%	0.75	Planoribidae sp.
Lepidostomatinae	Lepidostomatidae	Diptera	0.18%	0.75	Chironomidae sp. Pupae
Planorbidae sp.	Planorbidae	Pulmonata	0.18%	0.75	Mollusca sp.
Ceratopogonidae sp.	Ceratopogonidae	Diptera	0.09%	0.38	Nematoidea sp.
Conixidae	Conixidae	Hemiptera	0.09%	0.38	Pachydiplax
Gammaurus	Gammariidae	Amphipoda	0.09%	0.38	Belostomatidae
Simuliidae sp.	Simuliidae	Diptera	0.09%	0.38	Ceratopogonidae sp. Pupae
					Diptera sp. Pupae
					Halophilidae
					Total
				409.16	

taxa	family	order	relative abundances	densities (# / ft ²)	
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	16.97%	124.25	
Copepoda sp.	Copepoda sp.	Copepoda sp.	15.34%	112.28	
Cladocera sp.	Cladocera sp.	Cladocera sp.	14.11%	103.29	
Chironomidae	Chironomidae	Diptera	11.15%	81.59	
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae	Corbiculidae	9.30%	68.11	
Tanypodinae	Tanypodinae	Diptera	7.87%	57.63	
Physidae	Physidae	Diptera	4.40%	32.19	
Pulmonata	Pulmonata	Pulmonata	3.58%	26.20	
Lymnaeidae	Lymnaeidae	Pulmonata	3.07%	22.46	
Grammanthus	Grammanthus	Amphipoda	2.45%	17.96	
Ceratopogonidae	Ceratopogonidae	Diptera	2.35%	17.22	
Amphipoda sp.	Amphipoda sp.	Amphipoda	2.04%	14.97	
Odonata	Odonata	Odonata	1.84%	13.47	
Hempitera	Hempitera	Hempitera	1.23%	8.98	
Conidiaceae	Conidiaceae	Conidiaceae	0.72%	5.24	
Chironomidae	Chironomidae	Diptera	0.51%	3.74	
Sialidae	Sialidae	Megaloptera	0.51%	3.74	
Conixidae	Conixidae	Ephemeroptera	0.41%	2.99	
Corbiculidae	Corbiculidae	Hirudinea	0.31%	2.25	
Orthocladiinae	Orthocladiinae	Hydracarina sp.	0.31%	2.25	
Sialis	Sialis	Pulmonata	0.31%	2.25	
Callibaetis	Callibaetis	Chironomidae	0.20%	1.50	
Hirudinea sp.	Hirudinea sp.	Mollusca sp.	0.20%	1.50	
Hydracarina sp.	Hydracarina sp.	Nematoidea sp.	0.20%	1.50	
Planoribidae sp.	Planoribidae sp.	Odonata	0.20%	1.50	
Chironomidae sp. Pupae	Chironomidae sp. Pupae	Diptera	0.20%	1.50	
Mollusca sp.	Mollusca sp.	Hemiptera	0.10%	0.75	
Nematoidea sp.	Nematoidea sp.	Diptera	0.10%	0.75	
Pachydiplax	Pachydiplax	Diptera	0.10%	0.75	
Belostomatidae	Belostomatidae	Coleoptera	0.10%	0.75	
Ceratopogonidae sp. Pupae	Ceratopogonidae sp. Pupae	Haltipidae	0.10%	0.75	
Diptera sp. Pupae	Diptera sp. Pupae				
Halophilidae	Halophilidae				
					Total
				732.04	

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - AL03
date - 9/15/2001
glide

Aloha / Pheasant Park
Beaverton Creek, Aloha

site - AL06
date - 9/5/2001
glide

taxa	family	order	relative abundances	densities (# / ft ²)	
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	53.12%	111.86	
Juga	Pleuroceridae	Prostbranchia	17.29%	36.41	
Sphaeriidae / Corbiculidae sp.	Sphaeriidae / Corbiculidae	Corbiculidae	12.12%	25.53	
Corbicula	Corbiculidae	Corbiculidae	5.17%	10.89	
Isopoda sp.	Isopoda sp.	Isopoda sp.	2.32%	4.88	
Tanytarsinae	Chironomidae	Diptera	2.14%	4.50	
Gammareus	Gammareidae	Amphipoda	1.98%	4.13	
Sialis	Sialidae	Megaloptera	1.43%	3.00	
Probezzia	Ceratopogonidae	Diptera	1.25%	2.63	
Tanytarsini	Chironomidae	Diptera	1.07%	2.25	
Chironomidae sp.	Chironomidae	Diptera	0.53%	1.13	
Hyalella	Hyalellidae	Amphipoda	0.36%	0.75	
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	0.36%	0.75	
Chironomi	Chironomidae	Diptera	0.18%	0.38	
Collembola sp.	Collembola sp.	Collembola	0.18%	0.38	
Copepoda sp.	Copepoda sp.	Copepoda sp.	0.18%	0.38	
Nemato	Nematoidea sp.	Nematoidea sp.	0.18%	0.38	
Sminthuridae sp.	Sminthuridae	Collembola	0.18%	0.38	
				total	210.59

taxa	family	order	relative abundances	densities (# / ft ²)		relative abundances	densities (# / ft ²)
Tanytarsinae	Tanytarsini	Tanytarsini	53.12%	111.86		31.39%	266.47
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	17.29%	36.41		25.40%	215.57
Sphaeriidae / Corbiculidae	Chironomidae	Chironomidae	12.12%	25.53		11.55%	98.05
Corbicula	Oligochaeta sp.	Oligochaeta sp.	5.17%	10.89		7.23%	61.38
Isopoda sp.	Chironomidae	Chironomidae	2.32%	4.88		5.20%	44.16
Tanytarsinae	Sphaeriidae / Corbiculidae	Sphaeriidae / Corbiculidae	2.14%	4.50		2.56%	21.71
Gammareus	Corbiculidae	Corbiculidae	1.98%	4.13		2.29%	19.46
Sialis	Sialidae	Sialidae	1.43%	3.00		2.12%	17.96
Probezzia	Gammaidae	Gammaidae	1.25%	2.63		1.68%	8.98
Tanytarsini	Chironomidae	Chironomidae	1.07%	2.25		1.23%	10.48
Chironomidae sp.	Orthocladiinae	Orthocladiinae	0.53%	1.13		1.23%	10.48
Hyalella	Physidae sp.	Physidae sp.	0.36%	0.75		1.06%	14.22
Hydracarina sp.	Chironomidae	Chironomidae	0.36%	0.75		0.88%	7.49
Chironomi	Simuliidae	Simuliidae	0.18%	0.38		0.79%	6.74
Collembola sp.	Odonata sp.	Odonata sp.	0.18%	0.38		0.71%	5.99
Copepoda sp.	Amphipoda sp.	Amphipoda sp.	0.18%	0.38		0.62%	5.24
Nemato	Lymnaeidae	Lymnaeidae	0.18%	0.38		0.53%	4.49
Sminthuridae sp.	Isopoda sp.	Isopoda sp.	0.18%	0.38		0.53%	4.49
	Ostracoda sp.	Ostracoda sp.				0.53%	4.49
Prostemesinae	Chironomidae	Chironomidae				0.53%	4.49
Cheirifera	Empididae	Empididae				0.44%	3.74
Planoribidae sp.	Planoribidae	Planoribidae				0.44%	3.74
Collembola sp.	Collembola sp.	Collembola sp.				0.18%	1.50
Hirudinea sp.	Hirudinea	Hirudinea				0.18%	1.50
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.				0.18%	1.50
Nemato	Nematoidea sp.	Nematoidea sp.				0.18%	1.50
Sminthuridae sp. Pupae	Simuliidae	Simuliidae				0.18%	1.50
Diptera sp. Pupae	Diptera sp.	Diptera sp.				0.09%	0.75
Empididae sp. Pupae	Empididae	Empididae				0.09%	0.75
Ephemeroptera sp.	Ephemeroptera sp.	Ephemeroptera sp.				0.09%	0.75
Lepidostoma	Lepidostomatidae	Lepidostomatidae				0.09%	0.75
Limnephilidae sp. Pupae	Limnephilidae	Limnephilidae				0.09%	0.75
Musidae sp.	Musidae	Musidae				0.09%	0.75
Pyralidae sp.	Pyralidae	Pyralidae				0.09%	0.75
Syrphidae sp. Pupae	Syrphidae	Syrphidae				0.09%	0.75
					total		848.50

Appendix IV (cont.): Relative abundances and densities of all Invertebrate taxa

site - BE01
date - 9/25/2001
riffle

Murrayhill Homeowners
Summer Creek, Cooper Mountain

site - BE02
date - 9/4/2001
glide

taxa	family	order	relative abundances	densities (# / ft2)	
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	17.29%	8.25	
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	10.47%	5.00	Copepoda sp.
<i>Cinygma</i>	Hepageniidae	Ephemeroptera	9.42%	4.50	Oligochaeta sp.
Chironomini	Chironomidae	Diptera	8.64%	4.13	Chironomidae
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	8.64%	4.13	Chironomidae
Tanypodinae	Chironomidae	Diptera	7.33%	3.50	Chironomidae
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae	Corbiculaceae	6.54%	3.13	Sphaeridae / Corbiculidae
Gammareus	Gammaridae	Amphipoda	4.45%	2.13	Gammareidae
Isopoda sp.	Isopoda sp.	Isopoda sp.	3.66%	1.75	Physidae
<i>Simulium</i>	Simuliidae	Diptera	3.40%	1.63	Cladocera sp.
Physidae sp.	Physidae	Pulmonata	2.62%	1.25	Orthocladiinae
Rhyacophilida	Rhyacophilidae	Trichoptera	2.36%	1.13	Serromya
Tanytarsini	Chironomidae	Diptera	2.36%	1.13	Sialis
Chironomidae sp.	Chironomidae	Diptera	2.09%	1.00	Isopoda sp.
<i>Dicranota</i>	Tipulidae	Diptera	2.09%	1.00	<i>Hyallaea</i>
Dixa	Dixidae	Diptera	2.09%	1.00	Chironomidae sp. Pupae
Amphipoda sp.	Amphipoda sp.	Amphipoda	1.57%	0.75	Amphipoda sp.
Heptageniidae sp.	Heptageniidae	Ephemeroptera	1.05%	0.50	Chironomidae
<i>Cheififra</i>	Empididae	Diptera	0.52%	0.25	Conixidae
Chironomidae sp. Pupae	Chironomidae	Diptera	0.52%	0.25	Planorbidae sp.
Collembola sp.	Collembola sp.	Collembola	0.52%	0.25	Hydracarina sp.
Gastropoda sp.	Gastropoda sp.	Gastropoda sp.	0.52%	0.25	Aeshnidae
Ceratopogonidae	Ceratopogonidae	Diptera	0.28%	0.13	Colymbellinae sp.
Hydropsychidae sp.	Hydropsychidae	Trichoptera	0.26%	0.13	Lymantridae
Limnephilidae sp. Pupae	Limnephilidae	Trichoptera	0.26%	0.13	Ostracoda sp.
Odonata sp.	Odonata sp.	Odonata	0.26%	0.13	Prodaeinae
Sminthuridae sp.	Sminthuridae	Collembola	0.26%	0.13	Chironomidae
Trichoptera sp.	Trichoptera sp.	Trichoptera	0.26%	0.13	
Trichoptera sp. Pupae	Trichoptera sp.	Trichoptera	0.26%	0.13	
					total 47.75

taxa	family	order	relative abundances	densities (# / ft2)	
Copepoda sp.	Copepoda sp.	Copepoda sp.	25.16%	119.76	
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	13.84%	65.87	
<i>Cinygma</i>	Hepageniidae	Diptera	11.79%	56.14	
Chironomini	Chironomidae	Diptera	11.16%	53.14	
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	10.22%	48.65	
Tanypodinae	Tanypodinae	Diptera	7.23%	34.43	
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae	Corbiculacea	3.77%	17.96	
Gammareus	Gammareidae	Amphipoda	3.77%	17.96	
Isopoda sp.	Isopoda sp.	Pulmonata	3.77%	17.96	
<i>Simulium</i>	Simuliidae	Cladocera sp.	2.04%	9.73	
Physidae sp.	Physidae	Diptera	1.73%	8.23	
Rhyacophilida	Rhyacophilidae	Diptera	1.73%	8.23	
Tanytarsini	Chironomidae	Megatioplera	1.57%	7.49	
Chironomidae sp.	Chironomidae	Isopoda sp.	1.10%	5.24	
Chironomidae sp. Pupae	Chironomidae	Hyalellidae	0.94%	4.49	
Amphipoda sp.	Amphipoda	Diptera	0.79%	3.74	
Chironomidae sp.	Chironomidae	Amphipoda	0.63%	2.99	
Chironomidae	Chironomidae	Diptera	0.47%	2.25	
Conixidae	Conixidae	Hemiptera	0.47%	2.25	
Planorbidae sp.	Planorbidae	Pulmonata	0.47%	2.25	
Hydracarina sp.	Hydracarina	Hydracarina sp.	0.31%	1.50	
Aeshna	Aeshna	Odonata	0.16%	0.75	
Colymbellinae sp.	Colymbellinae	Coleoptera	0.16%	0.75	
Lymantridae	Lymantridae	Pulmonata	0.16%	0.75	
Ostracoda sp.	Ostracoda	Ostracoda sp.	0.16%	0.75	
Prodaeinae	Prodaeinae	Diptera	0.16%	0.75	
					total 476.05

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - BE03
date - 9/12/2001
glide

Public Utility / Hunters Woods HOA
Willow Creek, Cedar Mill

Tualatin Hills Nature Park
Cedar Johnson Creek, Beaverton

taxa	family	order	relative abundances	densities (# / ft ²)
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	34.48%	134.73
Tanypodinae	Chironomidae	Diptera	31.99%	125.00
Chironomini	Chironomidae	Diptera	12.84%	50.15
Sphaeritidae / Corbiculidae sp.	Sphaeritidae / Corbiculidae	Corbiculacea	12.45%	48.65
Juga	Pleuroceridae	Prosobranchia	3.07%	11.98
Orthocladiinae	Chironomidae	Diptera	1.53%	5.99
Sialis	Sialidae	Megaloptera	0.96%	3.74
Copepoda sp.	Copepoda sp.	Copepoda sp.	0.77%	2.99
Culicoides	Ceratopogonidae	Diptera	0.38%	1.50
Lera	Elmidae	Coleoptera	0.38%	1.50
Amphipoda sp.	Amphipoda sp.	Amphipoda	0.19%	0.75
Ciadowera sp.	Ciadowera sp.	Ciadowera sp.	0.19%	0.75
Empididae sp. Pupae	Empididae	Diptera	0.19%	0.75
Gammareus	Gammaridae	Amphipoda	0.19%	0.75
Isopoda sp.	Isopoda sp.	Isopoda sp.	0.19%	0.75
Prodaeasiniae	Chironomidae	Diptera	0.19%	0.75
		total		390.72

taxa	family	order	relative abundances	densities (# / ft ²)
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	85.97%	325.60
Tanypodinae	Chironomidae	Diptera	4.15%	15.72
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	2.77%	10.48
Tanytarsini	Chironomidae	Diptera	2.31%	8.98
Isopoda sp.	Isopoda sp.	Isopoda sp.	0.99%	3.74
Proboscidea	Ceratopogonidae	Diptera	0.99%	3.74
Sialis	Sialidae	Megaloptera	0.99%	3.74
Chironomini	Chironomidae	Diptera	0.59%	2.25
Serranomyia	Ceratopogonidae	Diptera	0.59%	2.25
Chironomidae sp. Pupae	Chironomidae	Diptera	0.40%	1.50
Corixidae sp.	Corixidae	Hemiptera	0.20%	0.75
		total		378.74

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - BE05
date - 9/13/2001
rifflle

Lowami Woods Hart Park / Brookhaven Park
Johnson Creek, Beaverton

site - 3001
date - 8/28/2001
riffle

Springwater Corridor
North Fork Deep Creek, Boring

taxa	family	order	relative abundances	densities (# / ft ²)
<i>Chaumatopsyche</i>	Hydropsychidae	Trichoptera	33.53%	339.82
Tanytarsini	Chironomidae	Diptera	14.48%	146.71
Orthocladiinae	Chironomidae	Diptera	14.33%	145.21
Chironomini	Chironomidae	Diptera	11.23%	113.77
Chironomidae sp.	Hydracarina sp.	Diptera	5.69%	57.63
Hydracarina sp.	Oligochaeta sp.	Hydracarina sp.	4.21%	42.66
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	3.32%	33.68
Chironomidae sp. Pupae	Chironomidae sp. Pupae	Diptera	3.03%	30.69
Sphaeridae sp.	Corticulaceae	Corticulaceae	1.48%	14.97
<i>Simulium</i>	Simuliidae	Diptera	1.40%	14.22
Hemerodromia	Empididae	Diptera	1.33%	13.47
Lymnaeidae sp.	Lymnaeidae	Pulmonata	0.89%	8.98
Nematida sp.	Nematida sp.	Nematoda sp.	0.89%	8.98
Bastidae sp.	Baetidae	Ephemeroptera	0.81%	8.23
Tanytarsinae	Chironomidae	Diptera	0.74%	7.49
Chelifera	Empididae	Diptera	0.66%	6.74
Argia	Coenagrionidae	Odonata	0.44%	4.49
Gammareus	Gammaridae	Amphipoda	0.37%	3.74
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	0.30%	2.99
Empididae sp. Pupae	Empididae	Diptera	0.22%	2.25
Sialis	Sialidae	Megaloptera	0.22%	2.25
Amphipoda sp.	Amphipoda	Amphipoda	0.15%	1.50
Isopoda sp.	Isopoda sp.	Isopoda sp.	0.15%	1.50
Empididae sp.	Empididae	Diptera	0.07%	0.75
Lara	Elmidae	Coleoptera	0.07%	0.75
				total 1013.47

taxa	family	order	relative abundances	densities (# / ft ²)
<i>Sphaeridae / Corbiculidae sp.</i>	Sphaeridae / Corbiculidae	Corbiculidae	60.20%	163.75
Orthocladiinae	Orthocladiinae	Diptera	9.42%	25.63
<i>Pseudocloeon</i>	Pseudocloeon	Ephemeroptera	7.90%	21.50
Juga	Juga	Prosbanchia	5.35%	14.63
		Oligochaeta sp.	4.78%	13.00
		Physidae	2.53%	6.88
		Lymnaeidae	2.34%	6.38
		Chironomidae	1.42%	3.88
		Chironomidae	1.29%	3.50
		Hydrobaenidae	1.01%	2.75
		Tanypodinae	0.46%	1.25
		Simuliidae	0.41%	1.13
		Nematoidea sp.	0.41%	1.13
		Pianoribidae	0.29%	0.63
		Chironomidae	0.25%	0.63
		Hydracarina sp.	0.14%	0.38
		Odonata	0.14%	0.38
		Coleoptera	0.09%	0.25
		Diptera	0.09%	0.25
		Trichoptera	0.05%	0.13
		Ephemeroptera	0.05%	0.13
		Diptera	0.05%	0.13
		Gastropoda sp.	0.05%	0.13
		Trichoptera	0.05%	0.13
		Gastropoda sp.	0.05%	0.13
		Hydropsychidae	0.05%	0.13
		Pyralidae	0.05%	0.13
		Simuliidae	0.05%	0.13
		Smithiuridae	0.05%	0.13
		Tipulidae	0.05%	0.13
				total 272.00

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - CO01
date - 9/5/2001
glide

Heather Park Dev. Co.
Carneolius

Durham City Park
Fanmo Creek, Durham

taxa	family	order	relative abundances	densities (# / ft ²)
Sphaeriidae / Corbiculidae sp.	Sphaeriidae / Corbiculidae	Corbiculacea	66.44%	720.15
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta	22.03%	238.81
Isopoda sp.	Isopoda sp.	Isopoda	4.65%	50.37
Gammarus	Gammaridae	Amphipoda	3.27%	35.45
Amphipoda sp.	Amphipoda sp.	Amphipoda	1.20%	13.06
Nematoda sp.	Nematoda sp.	Nematoda	0.69%	7.46
Hirudinea sp.	Hirudinea	Turbellaria	0.34%	3.73
Zygoptera sp.	Zygoptera sp.	Odonata	0.34%	3.73
Ceratopogonidae sp.	Ceratopogonidae	Diptera	0.17%	1.87
Ceratopogonidae sp. Pupae	Ceratopogonidae	Diptera	0.17%	1.87
Lymnaeidae sp.	Lymnaeidae	Pulmonata	0.17%	1.87
Orthocladinae	Chironomidae	Diptera	0.17%	1.87
Tanypodinae	Chironomidae	Diptera	0.17%	1.87
Turbellaria sp.	Turbellaria sp.	Turbellaria	0.17%	1.87
				total 1083.96

taxa	family	order	relative abundances	densities (# / ft ²)
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta	77.64%	182.43
Hydracarina sp.	Hydracarina sp.	Hydracarina	4.31%	10.14
Tanytarsini	Chironomidae	Diptera	4.15%	9.76
Gammaurus	Gammariidae	Amphipoda	2.24%	5.26
Ceratopogonidae sp.	Ceratopogonidae	Diptera	1.92%	4.50
Chironomidae sp. Pupae	Chironomidae	Diptera	1.92%	4.50
Tanypodinae	Chironomidae	Diptera	1.44%	3.38
Chironomidae sp.	Chironomidae	Diptera	1.12%	2.63
Copepoda sp.	Copepoda sp.	Copepoda	1.12%	2.63
Orthocladinae	Chironomidae	Diptera	0.96%	2.25
Amphipoda sp.	Amphipoda	Amphipoda	0.64%	1.50
Ostracoda sp.	Ostracoda	Ostracoda	0.48%	1.13
Sialis	Sialidae	Megaloptera	0.48%	1.13
Sphaeriidae / Corbiculidae sp.	Sphaeriidae / Corbiculidae	Corbiculacea	0.48%	1.13
Hydropsychidae sp.	Hydropsychidae	Trichoptera	0.32%	0.75
Nematoidea sp.	Nematoidea	Nematoda	0.32%	0.75
Cheumatopsyche	Hydropsychidae	Trichoptera	0.16%	0.38
Lara	Elmidae	Coleoptera	0.16%	0.38
Lymnaeidae sp.	Lymnaeidae	Pulmonata	0.16%	0.38
				total 234.98

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

Kane Road Neighborhood Park
Kelly Creek, Gresham

site - GR02
date - 8/27/2001

taxa	family	order	relative abundances	densities (# / 12)
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	45.09%	1094.70
Sphaeridae / Corbiculidae sp.	Corbiculidae	Corbiculidae	18.56%	450.76
Tanytarsini	Diptera	Diptera	7.49%	181.82
Chironomini	Diptera	Hirudinea	7.18%	174.24
Hirudinea sp.	Hirudinea	Amphipoda	6.24%	151.52
Gammareus	Amphipoda	Amphipoda	5.15%	125.00
Tanypodinae	Diptera	Diptera	1.72%	41.67
Chironomidae sp.	Chironomidae	Amphipoda	1.56%	37.88
Orthocladiinae	Amphipoda sp.	Amphipoda	1.40%	34.09
Stellis	Chironomidae	Diptera	1.40%	34.09
Coopepoda sp.	Sialidae	Megaloptera	1.08%	26.52
Chironomidae sp. Pupae	Coopepoda sp.	Copepoda sp.	0.78%	18.94
Nematoidea sp.	Chironomidae	Diptera	0.62%	15.15
Hydracarina sp.	Nematoidea sp.	Nematoidea sp.	0.62%	15.15
Corixidae	Hydracarina sp.	Hydracarina sp.	0.47%	11.36
Hyalellidae	Corixidae	Hemiptera	0.31%	7.58
Limnephilidae	Hyalellidae	Amphipoda	0.16%	3.79
Psychophlypha	Limnephilidae	Trichoptera	0.15%	3.79

Main City Park / Gresham Pioneer Cemetery /
Springwater Corridor
Saturnia Creek, Gresham

**Main City Park / Gresham Pioneer Cemetery /
Springwater Corridor**
Watson Creek, Gresham

Taxa	Family	order	relative abundances	densities (# / 102)
<i>Juga</i>	Pleuroceridae	Prostbranchia	16.14%	32.00
	Hydrobiidae	Prostbranchia	15.13%	30.00
	Lymnaeidae	Pulmonata	10.09%	20.00
	Leptophlebiidae	Ephemeroptera	9.46%	18.75
	Baetidae	Ephemeroptera	9.46%	18.75
	<i>Pseudocloeon</i>	Diptera	9.46%	18.75
	Tanypodinae	Diptera	8.95%	17.75
	Orthocladiinae	Hydracarina sp.	7.31%	14.50
	<i>Hydracarina</i> sp.	Diptera	5.30%	10.50
	Chironomidae	Diptera	3.55%	7.00
	Sphaeridae / Corbiculidae	Corbiculacea	3.03%	6.00
	Oligochaeta sp.	Oligochaeta sp.	2.90%	5.75
	Chironomidae	Diptera	1.77%	3.50
	Simuliidae	Diptera	1.64%	3.25
	Chironomidae	Diptera	1.51%	3.00
	Chironomidae	Diptera	0.78%	1.50
	Elmidae	Coleoptera	0.78%	1.50
	Hydropsychidae	Trichoptera	0.38%	0.75
	Hydropsyliidae	Trichoptera	0.38%	0.75
	Stalidae	Megaloptera	0.25%	0.50
	Ceratopogonidae	Diptera	0.13%	0.25
	Empididae	Diptera	0.13%	0.25
	Haplageniidae	Ephemeroptera	0.13%	0.25
	Empididae	Diptera	0.13%	0.25
	Collembola sp.	Collembola	0.13%	0.25
	Empididae sp. Pupae	Diptera	0.13%	0.25
	<i>Hemimordvia</i>	Diptera	0.13%	0.25
	Hydropsyliidae sp. Pupae	Trichoptera	0.13%	0.25
	Nematoidea sp.	Nematoda sp.	0.13%	0.25
	Simuliidae	Diptera	0.13%	0.25
				total

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - GRO3
date - 8/27/2001
rifile

site - CR04
date - 8/31/2001
rifile

taxa	family	order	relative abundances	densities (# / ft ²)	taxa	family	order	relative abundances	densities (# / ft ²)
Cheumatopsyche	Hydropsychidae	Trichoptera	19.50%	25.25	Physidae sp.	Pulmonata		22.55%	53.30
Juga	Pleuroceridae	Prosbbranchia	16.12%	20.88	Oligochaeta sp.	Oligochaeta sp.		18.60%	43.92
Paraleptophlebia	Leptophlebiidae	Ephemeroptera	15.93%	20.63	Sphaeridae / Corbiculidae	Corbiculidae		14.63%	34.53
Tanytarsini	Chironomidae	Diptera	7.34%	9.50	Chironomidae	Chironomidae		12.24%	28.90
Ancylidae / Lynnaeidae sp.	Ancylidae / Lynnaeidae	Pulmonata	6.56%	8.50	Tanypodinae	Diptera		8.74%	20.65
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae	Corbiculacea	6.18%	8.00	Chironomidae	Diptera		7.00%	16.52
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	4.15%	5.38	Chironomidae	Diptera		2.54%	6.01
Pseudocloeon	Baetidae	Ephemeroptera	4.05%	5.25	Orthocladiinae	Diptera		2.07%	4.88
Tanyopodinae	Chironomidae	Diptera	4.05%	5.25	Prodeamesinae	Diptera		1.43%	3.38
Chironomidae	Chironomidae	Diptera	3.96%	5.13	Chironomidae sp. Pupae	Diptera		1.11%	2.63
Chironomidae sp.	Chironomidae	Diptera	2.70%	3.50	Hydracarina sp.	Hydracarina sp.		1.11%	2.63
Chironomidae sp. Pupae	Chironomidae	Diptera	2.03%	2.63	Isopoda sp.	Isopoda sp.		1.11%	2.63
Opitoservus	Elmidae	Coloptera	1.54%	2.00	Nematoidea sp.	Nematoidea sp.		1.11%	2.63
Orthocladiinae	Chironomidae	Diptera	0.97%	1.25	Cholefiera	Diptera		0.64%	1.50
Lara	Elmidae	Coloptera	0.68%	0.88	Lara	Coloptera		0.64%	1.50
Gammarus	Gammaridae	Amphipoda	0.48%	0.63	Tiquila	Truliidae		0.64%	1.50
Sialis	Sialidae	Megaloptera	0.48%	0.63	Tiquila	Truliidae		0.48%	1.13
Simulium	Simuliidae	Diptera	0.48%	0.63	Pseudocloeon	Baetidae		0.48%	1.13
Elmidae sp.	Elmidae	Coloptera	0.39%	0.50	Collembola sp.	Collembola sp.		0.32%	0.75
Gastropoda sp.	Gastropoda sp.	Gastropoda sp.	0.29%	0.38	Ephemeroptera sp.	Ephemeroptera sp.		0.32%	0.75
Hydrobiidae sp.	Hydrobiidae	Prosbbranchia	0.29%	0.38	Hirudinea sp.	Hirudinea		0.32%	0.75
Glossosomatidae	Glossosomatidae	Trichoptera	0.19%	0.25	Limonia	Truliidae		0.32%	0.75
Heleciimetus	Elmidae	Coloptera	0.19%	0.25	Simulium	Simuliidae		0.32%	0.75
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	0.19%	0.25	Baetidae sp.	Baetidae		0.16%	0.38
Lepidostomatidae	Lepidostomatidae	Trichoptera	0.19%	0.25	Ceratopogonidae sp. Pupae	Ceratopogonidae		0.16%	0.38
Nematoidea sp.	Nematoidea sp.	Nematoidea sp.	0.19%	0.25	Dixa	Dixidae		0.16%	0.38
Trichoptera sp. Pupae	Trichoptera sp.	Trichoptera	0.19%	0.25	Dolichopodidae sp. Pupae	Dolichopodidae		0.16%	0.38
Cladocera sp.	Cladocera sp.	Cladocera sp.	0.10%	0.13	Gammarellidae	Gammarellidae		0.16%	0.38
Collembola sp.	Collembola sp.	Collembola	0.10%	0.13	Pleurocenidae	Pleurocenidae		0.16%	0.38
Dicheiro	Baetidae	Ephemeroptera	0.10%	0.13	Leptophlebiidae	Leptophlebiidae		0.16%	0.38
Opitoservus / Heterilimnus adult	Elmidae	Coloptera	0.10%	0.13	Planorbidae	Planorbidae		0.16%	0.38
Prosobranchia sp.	Prosobranchia sp.	Prosobranchia sp.	0.10%	0.13	Pulmonata	Pulmonata		0.16%	0.38
Salidiidae sp.	Salidiidae	Henriptera	0.10%	0.13					total 236.11
Tiquila	Tiquidae	Diptera	0.10%	0.13					total 129.50

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - GR05
date - 9/3/2001
riffle

Springwater Corridor
Johnson Creek, Gresham

site - GR06
date - 9/3/2001
riffle

taxa	family	order	relative abundances	densities (# / ft ²)
<i>Juga</i>	Pleuroceridae	Prosobranchia	24.51%	60.81
<i>Cheumatopsyche</i>	Hydropsychidae	Trichoptera	18.76%	46.55
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	15.75%	39.04
<i>Oligochaeta sp.</i>	Oligochaeta sp.	Oligochaeta sp.	8.02%	19.89
<i>Lymnaeidae sp.</i>	Lymnaeidae	Oligochaeta sp.	6.20%	15.39
<i>Tanytropidae</i>	Chironomidae	Pulmonata	6.20%	15.39
<i>Chironomini</i>	Chironomidae	Diptera	4.39%	10.89
<i>Hydrobiidae sp.</i>	Hydrobiidae	Diptera	3.18%	7.88
<i>Tanytarsini</i>	Chironomidae	Diptera	2.57%	6.38
<i>Orthocladiinae</i>	Chironomidae	Diptera	2.42%	6.01
<i>Paraleptophlebia</i>	Lepidophlebiidae	Ephemeroptera	2.42%	6.01
<i>Simulium</i>	Simuliidae	Diptera	1.82%	4.50
<i>Chironomidae sp.</i>	Chironomidae	Diptera	1.36%	3.38
<i>Chironomidae sp. Pupae</i>	Chironomidae	Diptera	0.91%	2.25
<i>Nematoidea sp.</i>	Nematoda sp.	Nematoda sp.	0.91%	2.25
<i>Lara</i>	Elmidae	Colleoptera	0.15%	0.38
<i>Odonata sp.</i>	Odonata sp.	Odonata	0.15%	0.38
<i>Sialis</i>	Sialidae	Megaloptera	0.15%	0.38
<i>Sphaeriidae / Corbiculidae sp.</i>	Sphaeriidae / Corbiculidae	Corbiculidae	0.15%	0.38
total				248.12

taxa	family	order	relative abundances	densities (# / ft ²)
<i>Turbellaria sp.</i>	Turbellaria sp.	Turbellaria sp.	39.56%	135.89
<i>Oligochaeta sp.</i>	Oligochaeta sp.	Oligochaeta sp.	31.48%	108.11
<i>Ostracoda sp.</i>	Ostracoda sp.	Ostracoda sp.	11.37%	39.04
<i>Tanypodine</i>	Chironomidae	Diptera	4.04%	13.89
<i>Chaumatosyche</i>	Hydropsychidae	Trichoptera	2.19%	7.51
<i>Amphipoda sp.</i>	Amphipoda sp.	Amphipoda	1.75%	6.01
<i>Gammareus</i>	Gammaridae	Amphipoda	1.64%	5.63
<i>Hydracarina sp.</i>	Hydracarina sp.	Hydracarina sp.	1.64%	5.63
<i>Chironomidae sp.</i>	Chironomidae	Diptera	1.31%	4.50
<i>Nematoidea sp.</i>	Nematoda sp.	Nematoda sp.	1.31%	4.50
<i>Tanytarsini</i>	Chironomidae	Diptera	1.20%	4.13
<i>Chironomini</i>	Chironomidae	Diptera	0.66%	2.25
<i>Juga</i>	Proteobranchia	Diptera	0.44%	1.50
<i>Orthocladiinae</i>	Chironomidae	Diptera	0.33%	1.13
<i>Sphaeriidae / Corbiculidae sp.</i>	Sphaeriidae / Corbiculidae	Corbiculidae	0.22%	0.75
<i>Baetidae sp.</i>	Baetidae	Ephemeroptera	0.11%	0.38
<i>Ceratopogonidae</i>	Ceratopogonidae	Diptera	0.11%	0.38
<i>Collembola sp.</i>	Collembola sp.	Collembola	0.11%	0.38
<i>Copepoda sp.</i>	Copepoda sp.	Copepoda sp.	0.11%	0.38
<i>Dixidae sp. Pupae</i>	Dixidae	Diptera	0.11%	0.38
<i>Stilifera</i>	Stilifera	Megaloptera	0.11%	0.38
<i>Simuliidae</i>	Simuliidae	Diptera	0.11%	0.38
<i>Tipula</i>	Tipulidae	Diptera	0.11%	0.38
total				343.47

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - HB02
date - 9/6/2001
Bethany Lake Park
Rock Creek, Bethany

site - HB03
date - 9/24/2001
Rock Creek, Merle
glide

taxa	family	order	relative abundances	densities (# / fl2)
Oligochaeta sp.	Oligochaeta sp.	Oligochaetae sp.	54.92%	221.56
Cladocera sp.	Cladocera sp.	Cladocera sp.	10.02%	40.42
Hydrobiidae sp.	Hydrobiidae	Prosobranchia	7.42%	29.94
Sphaeriidae / Corbiculidae sp.	Sphaeriidae / Corbiculidae	Corbiculidae	6.31%	25.45
Juga		Prosobranchia	6.12%	24.70
Pleuroceridae	Copepoda sp.	Copepoda sp.	2.97%	11.98
Copepoda sp.	Isopoda sp.	Isopoda sp.	2.78%	11.23
Chironomini		Diptera	2.04%	8.23
Chironomidae		Diptera	2.04%	8.23
Tanypodinae		Diptera	1.11%	1.50
Chironomidae	Ostracoda sp.	Ostracoda sp.	0.93%	3.74
Ostracoda sp.	Hyalella	Amphipoda	0.93%	3.74
Hyalella	Hydracarina sp.	Hydracarina sp.	0.93%	2.99
Hydracarina sp.	Sialis	Megaloptera	0.74%	2.25
Sialis	Chironomidae	Diptera	0.56%	4.49
Chironomidae sp.	Ostracoda sp.	Ostracoda sp.	0.37%	0.75
Ostracoda sp.	Coenagrionidae sp.	Odontata	0.19%	0.75
Coenagrionidae sp.	Collembola	Collembola	0.19%	0.75
Collembola sp.	Dixidae	Diptera	0.19%	0.75
Dixa	Ceratopogonidae	Diptera	0.19%	0.75
Probezzia				
		total	403.44	

taxa	family	order	relative abundances	densities (# / fl2)
Oligochaeta sp.	Oligochaeta sp.	Copepoda sp.	29.96%	54.43
Cladocera sp.	Oligochaeta sp.	Oligochaeta sp.	22.73%	41.29
Hydrobiidae	Cladocera sp.	Cladocera sp.	16.94%	30.78
Sphaeriidae / Corbiculidae sp.	Hydracarina sp.	Hydracarina sp.	13.84%	25.15
Juga	Chironomidae	Chironomidae		
Pleuroceridae	Ostracoda sp.	Ostracoda sp.	3.31%	6.01
Copepoda sp.	Ostracoda sp.	Ostracoda sp.	3.31%	6.01
Isopoda sp.	Tanypodinae	Tanypodinae	1.65%	3.00
Chironomini	Juga	Juga	1.24%	2.25
Chironomidae	Pleuroceridae	Pleuroceridae		
Tanypodinae	Collembola sp.	Collembola sp.	1.03%	1.88
Ostracoda sp.	Planorbidae	Planorbidae	1.03%	1.88
Hyalella	Sphaeriidae / Corbiculidae	Sphaeriidae / Corbiculidae	1.03%	1.88
Hydracarina sp.	Hydrobiidae	Hydrobiidae	0.62%	1.13
Sialis	Odontata sp.	Odontata sp.	0.62%	1.13
Chironomidae	Orthocladiinae	Orthocladiinae	0.62%	1.13
Chironomidae sp.	Physidae sp.	Physidae	0.62%	1.13
Ostracoda sp.	Sphaeriidae / Corbiculidae sp.	Sphaeriidae / Corbiculidae	0.41%	0.75
Coenagrionidae sp.	Amphipoda sp.	Amphipoda sp.	0.21%	0.38
Collembola sp.	Dixidae	Dixidae	0.21%	0.38
Dixa	Hyalellidae	Hyalellidae	0.21%	0.38
Probezzia	Psychodidae	Psychodidae	0.21%	0.38
	Tanyparsini	Tanyparsini	0.21%	0.38
		total	403.44	
				total
				181.68

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - HB04
date - 9/13/2001
Willow Creek Nature Park / Mushofsky Park
Stonegate Phase III Park
Willow Creek, Marlene Village

site - HB05
date - 10/3/2001
Rock Creek, Merle
glide

taxa	family	order	relative abundances	densities (# / fl2)
Hydrobiidae sp.	Hydrobiidae	Prosobranchia	48.54%	559.70
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	27.51%	317.16
Juga	Pleuroceridae	Prosobranchia	8.90%	102.61
Sphaeriidae / Corbiculidae sp.	Sphaeriidae / Corbiculidae	Corbiculacea	4.05%	46.64
Ostracoda sp.	Ostracoda sp.	Ostracoda sp.	2.75%	31.72
Tanypodinae	Diptera	Diptera	2.75%	31.72
Chironomini	Diptera	Diptera	1.29%	14.93
Physidae	Planimata	Planimata	0.81%	9.33
Sialis	Sialidae	Megaloptera	0.81%	9.33
Hyalella	Hyalellidae	Amphipoda	0.65%	7.46
Cladocera sp.	Cladocera sp.	Cladocera sp.	0.49%	5.60
Orthocladiinae	Chironomidae	Diptera	0.49%	5.60
Zygoplera sp.	Zygoplera sp.	Odonata	0.32%	3.73
Copepoda sp.	Copepoda sp.	Copepoda sp.	0.16%	1.87
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	0.16%	1.87
Planorbidae sp.	Planorbidae	Planimata	0.16%	1.87
Tanytarsini	Chironomidae	Diptera	0.16%	1.87
			total	1152.99

taxa	family	order	relative abundances	densities (# / fl2)
Hydrobiidae sp.	Hydrobiidae	Prosobranchia	48.54%	559.70
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	27.51%	317.16
Juga	Pleuroceridae	Isopoda sp.	8.90%	102.61
Sphaeriidae / Corbiculidae sp.	Sphaeriidae / Corbiculidae	Isopoda sp.	4.05%	46.64
Ostracoda sp.	Ostracoda sp.	Chironomidae	2.75%	31.72
Tanypodinae	Diptera	Chironomidae	2.75%	31.72
Chironomini	Diptera	Gammaridae	1.29%	14.93
Physidae	Planimata	Hydrobiidae	0.81%	9.33
Sialis	Sialidae	Pleuroceridae	0.32%	3.73
Hyalella	Hyalellidae	Sphaeriidae / Corbiculidae	0.16%	1.87
Cladocera sp.	Cladocera sp.	Sphaeriidae / Corbiculidae	0.16%	1.87
Orthocladiinae	Chironomidae	Sphaeriidae / Corbiculidae	0.16%	1.87
Zygoplera sp.	Zygoplera sp.	Copepoda sp.	0.16%	1.87
Copepoda sp.	Copepoda sp.	Amphipoda sp.	0.16%	1.87
Hydracarina sp.	Hydracarina sp.	Chironomidae	0.16%	1.87
Planorbidae sp.	Planorbidae	Sialis	0.16%	1.87
Tanytarsini	Chironomidae	Ceratopogonidae	0.16%	1.87
		Cladocera sp.	0.16%	1.87
		Corbiculidae	0.16%	1.87
		Lymnaeidae	0.16%	1.87
		Hydracarina sp.	0.16%	1.87
		Nematoidea sp.	0.16%	1.87
		Ostracoda sp.	0.16%	1.87
		Astacidae / Cambaridae sp.	0.16%	1.87
		Ephemeroptera sp.	0.16%	1.87
		Chironomidae	0.16%	1.87
		Unionidae	0.16%	1.87
				total
				465.23

Appendix IV (cont.): Relative abundances and densities of all Invertebrate taxa

site - HB06
date - 10/2/2001
glide

Honeywood Park / Chantal Village Park /
Arlida Park / Willow Creek West
Beaveron Creek, Alaska

taxa	family	order	relative abundances	densities (# / ft ²)
Oligochaeta sp.	Oligochaeta sp.	Oligochaetae sp.	62.75%	598.80
Corbicula	Corbiculidae	Corbiculacea	24.47%	233.53
Hydrobiidae sp.	Hydrobiidae	Prostobranchia	3.61%	34.43
Serromyia	Ceratopogonidae	Diptera	2.90%	27.69
Copepoda sp.	Copepoda sp.	Copepoda sp.	1.49%	14.22
Ostracoda sp.	Ostracoda sp.	Ostracoda sp.	1.41%	13.47
Chironomini	Chironomidae	Diptera	1.18%	11.23
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	0.47%	4.49
Physidae sp.	Physidae	Pulmonata	0.31%	2.99
Sialis	Sialidae	Megajoptera	0.31%	2.99
Tanypodinae	Chironomidae	Diptera	0.31%	2.99
Cladocera sp.	Cladocera sp.	Cladocera sp.	0.24%	2.25
Planorbidae sp.	Planorbidae	Pulmonata	0.16%	1.50
Turbellaria sp.	Turbellaria sp.	Turbellaria sp.	0.16%	1.50
Ceratopogonidae	Ceratopogonidae	Diptera	0.08%	0.75
Collembola sp.	Collembola sp.	Collembola	0.08%	0.75
Halipidae	Halipidae	Coleoptera	0.08%	0.75
				total 954.34

site - HB07
date - 9/11/2001
glide

Hamby Park / Jackson School
North Hillsboro

taxa	family	order	relative abundances	densities (# / ft ²)
Isopoda sp.	Isopoda sp.	Isopoda sp.	55.22%	536.95
Lymnaeidae sp.	Lymnaeidae	Pulmonata	9.38%	91.17
Physidae sp.	Physidae	Pulmonata	7.16%	69.55
Sphaeriidae / Corbiculidae	Sphaeriidae / Corbiculidae	Corbiculacea	6.00%	58.27
Tanypodinae	Tanypodinae	Diptera	5.13%	49.81
Coenagrion / Enallagma	Coenagrionidae	Odonata	3.00%	29.14
Copepoda sp.	Copepoda sp.	Copepoda sp.	2.80%	27.26
Tanytarsini	Tanytarsini	Diptera	1.93%	18.80
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	1.74%	16.92
Corbicula	Corbicula	Corbiculacea	1.64%	15.98
Planorbidae sp.	Planorbidae	Pulmonata	0.87%	8.46
Cladocera sp.	Cladocera sp.	Cladocera sp.	0.68%	6.58
Orthoceratidae	Chironomidae	Diptera	0.68%	6.58
Chironomini	Chironomidae	Chironomidae	0.58%	5.64
Amphipoda sp.	Amphipoda sp.	Amphipoda	0.48%	4.70
Gammarus	Gammaridae	Amphipoda	0.39%	3.76
Hirudinea sp.	Hirudinea	Hirudinea	0.39%	3.76
Ostracoda sp.	Ostracoda sp.	Ostracoda sp.	0.39%	3.76
Aeshnidae	Aeshnidae	Odonata	0.29%	2.82
Chironomidae	Chironomidae	Diptera	0.19%	1.88
Chaetifera	Empididae	Diptera	0.10%	0.94
Chironomidae sp. Pupae	Chironomidae	Diptera	0.10%	0.94
Collembola sp.	Collembola sp.	Collembola	0.10%	0.94
Dixa	Dixidae	Diptera	0.10%	0.94
Gastropoda sp.	Gastropoda sp.	Gastropoda sp.	0.10%	0.94
Gerridae sp.	Gerridae	Hemiptera	0.10%	0.94
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	0.10%	0.94
Hydrobiidae sp.	Hydrobiidae	Prosobranchia	0.10%	0.94
Hydrotupes	Dytiscidae	Coleoptera	0.10%	0.94
Paracyamus	Hydrophilidae	Coleoptera	0.10%	0.94
Pericoma / Telmatoscopus	Psychodidae	Diptera	0.10%	0.94
				total 971.80

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - HB08
date - 9/13/2001
glide
Bethany

Bethany Meadows Park / Springville
Meadows Park / Ben Graf Meadows Park
Bethany

site - HB10
date - 9/24/2001
glide

Nofziger Property / Upper Rock Creek
Open Space
Rock Creek, Marie

taxa	family	order	relative abundances	densities (# / #12)	taxa	family	order	relative abundances	densities (# / #12)
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	20.22%	94.31	Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	18.94%	25.00
Tanytarsini	Chironomidae	Diptera	18.75%	87.57	Isopoda sp.	Isopoda sp.	Isopoda sp.	14.96%	19.75
Sphaeriidae / Corbiculidae sp.	Sphaeriidae / Corbiculidae	Corbiculidae	16.05%	74.85	Pleuroceridae	Prosobranchia	Prosobranchia	12.50%	16.50
Tanypodinae	Chironomidae	Diptera	13.64%	63.62	Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	11.17%	14.75
Copepoda sp.	Copepoda sp.	Copepoda sp.	5.14%	23.95	Chironomidae	Chironomidae	Chironomidae	7.77%	10.25
Gammarus	Amphipoda	Amphipoda	3.53%	16.47	Hydrobiidae	Hydrobiidae	Hydrobiidae	7.77%	10.25
Ostracoda sp.	Ostracoda sp.	Ostracoda sp.	2.73%	12.72	Copepoda sp.	Copepoda sp.	Copepoda sp.	6.82%	9.00
Chironomini	Chironomidae	Diptera	2.57%	11.98	Tanypodinae	Chironomidae	Diptera	6.63%	8.75
Chironomidae sp. Pupae	Chironomidae	Diptera	2.41%	11.23	Probezza	Ceratopogonidae	Diptera	2.27%	3.00
Physidae sp.	Physidae	Pulmonata	2.09%	9.73	Chironomidae	Chironomidae	Diptera	1.89%	2.50
Amphipoda sp.	Amphipoda	Amphipoda	1.93%	8.98	Corbicula	Corbiculidae	Diptera	1.70%	2.25
Orthocladinae	Chironomidae	Diptera	1.93%	8.98	Ceratopogonidae	Ceratopogonidae	Diptera	1.33%	1.75
Isopoda sp.	Isopoda sp.	Isopoda sp.	1.44%	6.74	Cladocera sp.	Cladocera sp.	Cladocera sp.	1.33%	1.75
Chironomidae sp.	Chironomidae	Diptera	1.28%	5.99	Sphaeriidae / Corbiculidae	Sphaeriidae / Corbiculidae	Corbiculacea	0.95%	1.25
Prodeamesinae	Chironomidae	Diptera	1.12%	5.24	Staflis	Staflidae	Megaloptera	0.76%	1.00
Sialis	Sialidae	Diptera	0.80%	3.74	Collembola sp.	Collembola sp.	Collembola	0.57%	0.75
Dicella	Dixidae	Diptera	0.64%	2.99	Leptophlebiidae	Leptophlebiidae	Ephemeroptera	0.57%	0.75
Bezzia / Palpomyia	Ceratopogonidae	Diptera	0.48%	2.25	Nematoidea sp.	Nematoidea sp.	Nematoidea sp.	0.38%	0.50
Aedes	Culicidae	Diptera	0.32%	1.50	Orthocladinae	Chironomidae	Diptera	0.38%	0.50
Ceratopogon	Ceratopogonidae	Diptera	0.32%	1.50	Astaciidae / Cambaridae	Astaciidae / Cambaridae	Decapoda	0.19%	0.25
Dicranota	Tipulidae	Diptera	0.32%	1.50	Chironomidae sp. Pupae	Chironomidae	Diptera	0.19%	0.25
Diptera sp. Pupae	Diptera sp.	Diptera	0.32%	1.50	Gammarellus	Gammarellidae	Amphipoda	0.19%	0.25
Hirudinea sp.	Hirudinea	Hirudinea	0.32%	1.50	Lymnaeidae sp.	Lymnaeidae	Pulmonata	0.19%	0.25
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	0.32%	1.50	Prodeamesinae	Chironomidae	Diptera	0.19%	0.25
Lepidostoma	Lepidostomatidae	Diptera	0.32%	1.50	Seromyia	Ceratopogonidae	Diptera	0.19%	0.25
Cheirifera	Empididae	Diptera	0.16%	0.75	Tanytarsini	Chironomidae	Diptera	0.19%	0.25
Collembola sp.	Collembola sp.	Collembola	0.16%	0.75	total	466.32			
Colymbetinae sp.	Dytiscidae	Dytiscidae	0.16%	0.75					
Gastropoda sp.	Gastropoda	Gastropoda	0.16%	0.75					
Planorbidae sp.	Planorbidae	Planorbidae	0.16%	0.75					
Simuliidae sp. Pupae	Simuliidae	Diptera	0.16%	0.75					

total

132.00

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - HB11
date - 9/13/2001
glide

site - HB12
date - 9/25/2001
glide

taxa	family	order	relative abundances	densities (# / 12)	
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae	Corbiculidae	42.66%	113.36	
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	24.44%	64.94	
Tanypodinae	Chironomidae	Diptera	10.31%	27.40	
Juga	Pleuroceridae	Prosobranchia	8.47%	22.52	
Hydrobidae sp.	Hydrobidae	Prosobranchia	3.25%	8.63	
Chironomini	Chironomidae	Diptera	2.40%	6.38	
Tanytarsini	Chironomidae	Diptera	2.12%	5.63	
Sialis	Sialidae	Megaloptera	0.99%	2.63	
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	0.85%	2.25	
Gammareus	Gammareidae	Amphipoda	0.71%	1.88	
Copepoda sp.	Copepoda sp.	Copepoda sp.	0.56%	1.50	
Ostracoda sp.	Ostracoda sp.	Ostracoda sp.	0.56%	1.50	
Corbicula	Corbiculidae	Corbiculidae	0.42%	1.13	
Probaetis	Ceratopogonidae	Diptera	0.42%	1.13	
Seromyia	Ceratopogonidae	Diptera	0.42%	1.13	
Chironomidae sp.	Chironomidae	Diptera	0.28%	0.75	
Isopoda sp.	Isopoda sp.	Isopoda sp.	0.28%	0.75	
Odonata sp.	Odonata sp.	Odonata sp.	0.28%	0.75	
Cladocera sp.	Cladocera sp.	Cladocera sp.	0.28%	0.75	
Diptera sp. Pupae	Diptera sp.	Diptera	0.14%	0.38	
Orthoceratinae	Chironomidae	Diptera	0.14%	0.38	
Prodrassiminae	Chironomidae	Diptera	0.14%	0.38	
					total 265.77

taxa	family	order	relative abundances	densities (# / 12)	
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	40.71%	285.00	
Physidae sp.	Physidae	Pulmonata	6.61%	46.25	
Gammareus	Gammareidae	Amphipoda	6.43%	45.00	
Tanytarsini	Chironomidae	Diptera	6.43%	45.00	
Tanytarsini	Chironomidae	Diptera	6.25%	43.75	
Tanytarsinae	Chironomidae	Isopoda sp.	5.71%	40.00	
Isopoda sp.	Copepoda sp.	Copepoda sp.	4.46%	31.25	
Copepoda sp.	Copepoda sp.	Diptera	4.29%	30.00	
Chironomini	Chironomidae	Diptera	2.50%	17.50	
Orthoceratinae	Orthoceratinae	Corbiculacea	2.32%	16.25	
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae sp.	Amphipoda	2.14%	15.00	
Hyalella	Hyalellidae	Amphipoda	1.79%	12.50	
Amphipoda sp.	Amphipoda sp.	Ostracoda sp.	1.79%	12.50	
Ostracoda sp.	Ostracoda sp.	Dixidae	1.25%	8.75	
Cladocera sp.	Cladocera sp.	Hydracarina sp.	1.07%	7.50	
Hydracarina sp.	Hydracarina sp.	Sialis	1.07%	7.50	
Sialis	Sialis	Chironomidae	0.89%	6.25	
Chironomidae sp.	Chironomidae	Cladocera sp.	0.71%	5.00	
Cladocera sp.	Cladocera sp.	Branchiobdellida sp.	0.54%	3.75	
Branchiobdellida sp.	Branchiobdellida sp.	Dytiscidae	0.54%	3.75	
Colymbellinae sp.	Colymbellinae sp.	Planorbidae	0.54%	3.75	
Planorbidae sp.	Planorbidae	Chironomidae	0.36%	2.50	
Chironomidae sp. Pupae	Chironomidae	Dixidae	0.36%	2.50	
Dixidae sp. Pupae	Dixidae	Collembola	0.18%	1.25	
Collembola sp.	Collembola	Diptera	0.18%	1.25	
Diptera sp. Pupae	Diptera	Empididae	0.18%	1.25	
Empididae sp. Pupae	Empididae	Odonata sp.	0.18%	1.25	
Odonata sp.	Odonata	Pachydiplax	0.18%	1.25	
Pachydiplax	Pericoma / Telmatoscopus	Psychodidae	0.18%	1.25	
Pericoma / Telmatoscopus	Turbellaria sp.	Turbellaria sp.	0.18%	1.25	
Turbellaria sp.					total 700.00

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - HB13
date - 3/25/2001
glide

Middle Rock Cr. Open Space / Dawson Cr.
Properties / Creekside
Rock Creek, Oregon

site - HB14
date - 3/30/2001
glide

Valley Memorial Park Cemetery
Rock Creek, Newton

taxa	family	order	relative abundances	densities (# / #2)
Oligochaeta sp.	Oligochaetae sp.	Oligochaetae sp.	29.65%	54.43
Juga	Pleuroceridae	Prosobranchia	23.11%	42.42
Chironomini	Chironomidae	Diptera	14.52%	26.65
Tanypodinae	Chironomidae	Diptera	13.70%	25.15
Hydrodilidae sp.	Hydrodilidae	Prosobranchia	4.03%	7.51
Sphaeriidae / Corbiculidae sp.	Sphaeriidae / Corbiculidae	Corbiculacea	3.48%	6.38
Isopoda sp.	Isopoda sp.	Isopoda sp.	2.45%	4.50
Corbicula	Corbiculidae	Corbiculacea	2.04%	3.75
Gammareus	Gammareidae	Amphipoda	1.84%	3.00
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	1.43%	2.63
Chironomidae sp. Pupae	Chironomidae	Diptera	1.02%	1.88
Copepoda sp.	Copepoda sp.	Copepoda sp.	0.61%	1.13
Probedza	Ceratopogonidae	Diptera	0.61%	1.13
Nemaloda sp.	Nemaloda sp.	Nemaloda sp.	0.41%	0.75
Orthocadline	Chironomidae	Diptera	0.41%	0.75
Chironomidae sp.	Chironomidae	Diptera	0.20%	0.38
Collombola sp.	Collombola	Collembola	0.20%	0.38
Lymnaeidae	Pulmonata	Pulmonata	0.20%	0.38
Sialis	Megaloptera	Megaloptera	0.20%	0.38
		total		183.56

taxa	family	order	relative abundances	densities (# / #2)
Oligochaeta sp.	Oligochaetae sp.	Oligochaetae sp.	25.75%	95.81
Hydrobidae sp.	Hydrobidae	Prosobranchia	23.14%	86.08
Sphaeriidae / Corbiculidae sp.	Sphaeriidae / Corbiculidae	Corbiculacea	13.28%	49.40
Gammareus	Gammareidae	Amphipoda	10.06%	31.43
Chironomini	Chironomidae	Diptera	7.44%	27.69
Corbicula	Corbiculidae	Corbiculacea	5.23%	19.46
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	3.62%	13.47
Juga	Pleuroceridae	Prosobranchia	3.62%	13.47
Chironomidae	Chironomidae	Diptera	1.81%	6.74
Amphipoda	Amphipoda	Amphipoda	1.41%	5.24
Chironomidae sp. Pupae	Chironomidae	Diptera	1.41%	5.24
Chironomidae sp.	Chironomidae	Diptera	0.80%	2.99
Lymnaeidae	Lymnaeidae	Pulmonata	0.60%	2.25
Copepoda sp.	Copepoda sp.	Copepoda sp.	0.40%	1.50
Isopoda sp.	Isopoda sp.	Isopoda sp.	0.40%	1.50
Lara	Elmidae	Coleoptera	0.40%	1.50
Forcipomyia	Ceratopogonidae	Diptera	0.20%	0.75
Hyalella	Hyalellidae	Amphipoda	0.20%	0.75
Mystacides	Leptoceridae	Trichoptera	0.20%	0.75
	total			372.01

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - L-001
date - 10/22/2001
glide

Bryant Woods Park (Private)

Lake Oswego

North Clackamas Central Park
Kellogg Creek, Milwaukie

site - M101
date - 8/24/2001
rifile

taxa	family	order	relative abundances	densities (# / 112)
Sphaeridae sp.	Sphaeridae	Corbiculidae	51.82%	445.00
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	19.80%	170.00
Hydrobiidae sp.	Hydrobiidae	Frosobranchia	7.57%	65.00
Juga sp.	Pleuroceridae	Frosobranchia	4.05%	35.00
Copepoda sp.	Copepoda sp.	Copepoda sp.	3.78%	32.50
Cladocera sp.	Cladocera sp.	Cladocera sp.	2.33%	20.00
Chironomidae sp.	Chironomidae	Diptera	1.89%	16.25
Chironomini	Chironomidae	Diptera	1.89%	16.25
Tanypodinae	Tanypodinae	Diptera	1.89%	16.25
Amphipoda sp.	Amphipoda sp.	Amphipoda	1.02%	8.75
Gammareus	Gammareus	Amphipoda	0.87%	7.50
Berzia / Palpomyia	Ceratopogonidae	Diptera	0.58%	5.00
Sialis	Sialis	Megaloptera	0.58%	5.00
Ostracoda sp.	Ostracoda sp.	Ostracoda sp.	0.44%	3.75
Corbicula	Corbiculidae	Corbiculidae	0.25%	2.50
Hirudinea	Hirudinea	Hirudinea	0.25%	2.50
Nematoidea sp.	Nematoidea sp.	Nematoidea sp.	0.25%	2.50
Prostomatinae	Prostomatinae	Diptera	0.29%	2.50
Lymnaeidae sp.	Lymnaeidae	Pulmonata	0.15%	1.25
Unionidae sp.	Unionidae	Unionacea	0.15%	1.25
				total 858.75

taxa	family	order	relative abundances	densities (# / 112)
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae sp.	Corbiculidae	30.84%	117.51
Juga	Juga	Pleuroceridae	17.29%	65.87
Hydrobiidae sp.	Hydrobiidae	Hydrobiidae	11.20%	42.66
Chemalopsyc	Hydropsychidae	Hydropsychidae	9.43%	35.93
Isopoda sp.	Isopoda sp.	Isopoda sp.	8.25%	31.44
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	4.91%	18.71
Gammareus	Gammareidae	Amphipoda	3.93%	14.97
Lymnaeidae sp.	Lymnaeidae	Pulmonata	3.73%	14.22
Pseudocloeon	Baetidae	Ephemeroptera	2.95%	11.23
Tanypodinae	Chironomidae	Diptera	1.77%	6.74
Amphipoda sp.	Amphipoda sp.	Amphipoda	1.18%	4.49
Nematoidea sp.	Nematoidea sp.	Nematoidea sp.	0.59%	2.25
Tanytarsini	Chironomidae	Diptera	0.59%	2.25
Chironomini	Chironomidae	Diptera	0.39%	1.50
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	0.39%	1.50
Hydropsyche	Hydropsyche	Trichoptera	0.39%	1.50
Hydropsyche	Hydropsyche	Trichoptera	0.39%	1.50
Lepidostomata	Lepidostomata	Diptera	0.39%	1.50
Simuliidae sp.	Simuliidae	Diptera	0.20%	0.75
Antocha	Tipulidae	Diptera	0.20%	0.75
Chironomidae sp. Pupae	Chironomidae	Coleoptera	0.20%	0.75
Lara	Elmidae	Diptera	0.20%	0.75
Orthocladiinae	Chironomidae	Odontata	0.20%	0.75
Zygoptera sp.	Zygoptera sp.			total 380.99

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - MCCR
date - 10/1/2001
glide

taxa	family	order	relative abundances	densities (# / f12)
<i>Paraleptophlebia</i>	Lepidophlebiidae	Ephemeroptera	17.84%	15.88
<i>Ophiotervus</i>	Elmidae	Coleoptera	11.94%	10.53
<i>Juga</i>	Pleuroceridae	Prosobranchia	9.83%	8.75
<i>Oligochaeta sp.</i>	Oligochaeta sp.	Oligochaeta sp.	9.41%	8.38
<i>Lymnaeidae sp.</i>	Lymnaeidae	Pulmonata	7.87%	7.00
<i>Chironomini</i>	Chironomidae	Diptera	6.88%	6.13
<i>Swiftsa</i>	Chloroperlidae	Plecoptera	6.18%	5.50
<i>Hydrobidae sp.</i>	Hydrobidae	Prosobranchia	4.78%	4.25
<i>Orthocladinae</i>	Chironomidae	Diptera	2.95%	2.63
<i>Ampuniiks</i>	Elmidae	Coleoptera	2.11%	1.88
<i>Ophiotervus / Heterlimnius adult</i>	Elmidae	Coleoptera	2.11%	1.88
<i>Hydracarina sp.</i>	Hydracarina sp.	Hydracarina sp.	1.46%	1.25
<i>Zapada</i>	Namoundidae	Plecoptera	1.46%	1.25
<i>Collembola sp.</i>	Collembola sp.	Collembola	1.26%	1.13
<i>Hexatoma</i>	Tipulidae	Diptera	1.26%	1.13
<i>Sialis</i>	Sialidae	Neglopelta	1.26%	1.13
<i>Tanytarsini</i>	Chironomidae	Diptera	1.26%	1.13
<i>Chironomidae sp. Pupae</i>	Chironomidae	Diptera	1.12%	1.00
<i>Epeorus</i>	Heptageniidae	Ephemeroptera	0.84%	0.75
<i>Rhithrogena</i>	Heptageniidae	Ephemeroptera	0.84%	0.75
<i>Antocha</i>	Tipulidae	Diptera	0.70%	0.63
<i>Heterlimnius</i>	Elmidae	Coleoptera	0.70%	0.63
<i>Nemastoda sp.</i>	Nematoidea sp.	Nematoidea sp.	0.70%	0.63
<i>Cheilifera</i>	Empididae	Diptera	0.42%	0.38
<i>Chloroperlidae sp.</i>	Chloroperlidae	Plecoptera	0.42%	0.38
<i>Narpus</i>	Elmidae	Coleoptera	0.42%	0.38
<i>Astaciidae / Cambaridae sp.</i>	Astaciidae / Cambariidae	Decapoda	0.28%	0.25
<i>Baetidae sp.</i>	Baetidae	Ephemeroptera	0.28%	0.25
<i>Elmidae sp.</i>	Elmidae	Coleoptera	0.28%	0.25
<i>Goera</i>	Gerridae	Trichoptera	0.28%	0.25
<i>Probeziza</i>	Ceratopogonidae	Diptera	0.28%	0.25
<i>Rhyacophilidae</i>	Rhyacophilidae	Trichoptera	0.28%	0.25
<i>Sphaeridae / Corbiculidae</i>	Sphaeridae / Corbiculidae	Corticulaceae	0.28%	0.25
				total 89.00

taxa	family	order	relative abundances	densities (# / f12)
<i>Tanypodinae</i>	Chironomidae	Diptera	0.28%	0.25
<i>Gerridae sp.</i>	Gerridae	Hemiptera	0.14%	0.13
<i>Lepidostomatidae</i>	Lepidostomatidae	Trichoptera	0.14%	0.13
<i>Limnephilidae sp.</i>	Limnephilidae	Trichoptera	0.14%	0.13
<i>Micrasema</i>	Brachyceridae	Trichoptera	0.14%	0.13
<i>Peritidae sp.</i>	Peritidae	Plecoptera	0.14%	0.13
<i>Plecoptera sp.</i>	Plecoptera	Plecoptera	0.14%	0.13
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	0.14%	0.13
<i>Serratella</i>	Ephemerellidae	Ephemeroptera	0.14%	0.13
<i>Simulium</i>	Simuliidae	Diptera	0.14%	0.13
<i>Sminthuridae sp.</i>	Sminthuridae	Collembola	0.14%	0.13
<i>Sunella</i>	Chironoporidae	Plecoptera	0.14%	0.13
<i>Turbellaria sp.</i>	Turbellaria sp.	Turbellaria sp.	0.14%	0.13
<i>Unionidae sp.</i>	Unionidae	Unionacea	0.14%	0.13
				total 89.00

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - P001
date - 8/28/2001
riffle

Marshall Park
Troy Creek, Englewood / Lake Oswego

taxa	family	order	relative abundances	densities (# / 112)
<i>Pseudocloeon</i>		Ephemeroptera	21.67%	11.38
<i>Hydracarina</i> sp.	Hydracarina sp.	Hydracarina sp.	15.00%	7.88
<i>Oligochaeta</i> sp.	Oligochaeta sp.	Oligochaeta sp.	13.10%	6.88
<i>Orthocladiinae</i>	Chironomidae	Diptera	11.19%	5.88
<i>Tanytarsini</i>	Chironomidae	Diptera	10.24%	5.38
<i>Ancylidae / Lynnaeidae</i> sp.	Ancylidae / Lynnaeidae	Pulmonata	5.71%	3.00
<i>Gammarus</i>	Gammaridae	Amphipoda	5.71%	3.00
<i>Chironomidae</i> sp.	Chironomidae	Diptera	3.33%	1.75
<i>Physidae</i> sp.	Physidae	Pulmonata	2.86%	1.50
<i>Simulium</i>	Simuliidae	Diptera	2.88%	1.50
<i>Hirudinea</i> sp.	Hirudinea	Hirudinea	1.90%	1.00
<i>Chironomidae</i> sp. <i>Pupae</i>	Chironomidae	Diptera	1.19%	0.63
<i>Tanypodinae</i>	Chironomidae	Diptera	0.99%	0.50
<i>Amphipoda</i> sp.	Amphipoda	Amphipoda	0.71%	0.38
<i>Copepoda</i> sp.	Copepoda sp.	Copepoda sp.	0.71%	0.38
<i>Hydropsychie</i>	Hydropsychidae	Trichoptera	0.71%	0.38
<i>Nematoda</i> sp.	Nematoda sp.	Nematoda sp.	0.71%	0.38
<i>Ceratopogonidae</i> sp.	Ceratopogonidae	Diptera	0.24%	0.13
<i>Gerridae</i> sp.	Gerridae	Hemiptera	0.24%	0.13
<i>Hydropsyliidae</i> sp. <i>Pupae</i>	Hydropsyliidae	Trichoptera	0.24%	0.13
<i>Limonia</i>	Tipulidae	Diptera	0.24%	0.13
<i>Psychoglypha</i>	Limnephilidae	Trichoptera	0.24%	0.13
<i>Sphaeriidae / Corbiculidae</i> sp.	Sphaeriidae / Corbiculidae	Corbiculacea	0.24%	0.13
		total		52.50

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - P002
date - 1/01/2001
riffle
Tryon Creek State Park South
Tryon Creek, Englewood / Lake Oswego

taxa	family	order	relative abundances	densities (# / ft ²)
Oligochaeta sp.	Oligochaeta sp.	Ciliogochaeta sp.	36.94%	35.00
Hydropsyche	Hydropsychidae	Trichoptera	14.12%	13.38
Paraleptophlebia	Lepidophlebiidae	Ephemeroptera	10.29%	9.75
Tanytarsini	Chironomidae	Diptera	7.26%	6.88
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	6.33%	6.00
Cinygma	Heptageniidae	Ephemeroptera	3.56%	3.38
Orthocladiinae	Chironomidae	Diptera	3.17%	3.00
Pseudocloeon	Baetidae	Ephemeroptera	3.17%	3.00
Tanypodinae	Chironomidae	Diptera	2.11%	2.00
Juga	Pauroporidae	Prosobranchia	1.98%	1.88
Baetidae sp.	Baetidae	Ephemeroptera	1.58%	1.50
Lara	Elmidae	Coleoptera	1.45%	1.38
Chironomidae sp. - Pupae	Chironomidae	Diptera	1.19%	1.13
Heptageniidae sp.	Heptageniidae	Ephemeroptera	0.92%	0.88
Psephenidae sp. - Pupae	Psephenidae	Coleoptera	0.53%	0.50
Sialis	Sialidae	Megaloptera	0.53%	0.50
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae	Corbiculacea	0.53%	0.50
Simulium	Simuliidae	Diptera	0.40%	0.38
Chironomidae sp.	Chironomidae	Diptera	0.26%	0.25
Dicranota	Tipulidae	Diptera	0.26%	0.25
Dixa	Dixidae	Diptera	0.26%	0.25
Gammarus	Gammaridae	Diptera	0.26%	0.25
Isopoda sp.	Isopoda sp.	Amphipoda	0.26%	0.25
Nemouridae sp.	Nemouridae	Isopoda sp.	0.26%	0.25
Pericoma / Telmatoscopus	Psychodidae	Psocoptera	0.26%	0.25
Physidae sp.	Physidae	Diptera	0.26%	0.25
		Pulmonata	0.26%	0.25
				Total 94.75

taxa	family	order	relative abundances	densities (# / ft ²)
Amphipoda sp.	Amphipoda sp.	Amphipoda	0.13%	0.13
Collembola sp.	Collembola sp.	Collembola	0.13%	0.13
Corbiculidae	Corbiculidae	Corbiculacea	0.13%	0.13
Ephemeroptera sp.	Ephemeroptera sp.	Ephemeroptera	0.13%	0.13
Limnephilidae sp. - Pupae	Limnephilidae	Limnephilidae	0.13%	0.13
Limnia	Limnia	Trichoptera	0.13%	0.13
Nematoda sp.	Nematoda sp.	Diptera	0.13%	0.13
Physidae sp.	Physidae sp.	Nematoda sp.	0.13%	0.13
Pisana	Pisana	Pulmonata	0.13%	0.13
Planorbidae sp.	Planorbidae	Pulmonata	0.13%	0.13
Prodamselfiniae	Prodamselfiniae	Chironomidae	0.13%	0.13
Rhabdomastix	Rhabdomastix	Tipulidae	0.13%	0.13
Rhyacophilidae	Rhyacophilidae	Rhyacophilidae	0.13%	0.13
Simuliidae sp. - Pupae	Simuliidae	Simuliidae	0.13%	0.13
Trichoptera sp.	Trichoptera sp.	Trichoptera	0.13%	0.13
				Total 94.75

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

Tryon Creek State Park North
Tryon Creek, Englewood / Lake Oswego

site - PO08 date - 9/19/2001
Jordan Park Mill Creek, Bonny Slope

Taxa	family	order	relative abundances	densities (# / 10 ²)
<i>Oligochaeta</i> sp.	Oligochaeta sp.	Oligochaeta sp.	30.22%	77.75
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	27.31%	70.25
Tanytarsini	Chironomidae	Diptera	10.11%	26.00
<i>Hydropsyche</i>	Hydropsychidae	Trichoptera	7.97%	20.50
Orthocladiinae	Chironomidae	Diptera	6.03%	15.50
<i>Hydracarina</i> sp.	Hydracarina sp.	Hydracarina sp.	3.21%	8.25
Chironomidae	Chironomidae	Diptera	2.82%	7.25
<i>Simulium</i>	Simuliidae	Diptera	2.53%	6.50
Chironomidae sp.	Chironomidae	Diptera	1.94%	5.00
<i>Juga</i>	Pleuroceridae	Prostrobranchia	1.65%	4.25
Tanypodinae	Chironomidae	Diptera	1.17%	3.00
Ancylidae / Lynnaeidae	Ancylidae / Lynnaeidae	Pulmonata	0.97%	2.50
Lepidophlebiidae	Lepidophlebiidae	Ephemeroptera	0.97%	2.50
Chironomidae	Chironomidae	Diptera	0.58%	1.50
<i>Tipula</i>	Tipulidae	Diptera	0.33%	1.00
Amphipoda sp.	Amphipoda	Amphipoda	0.28%	0.75
<i>Dicranota</i>	Tipulidae	Diptera	0.28%	0.75
<i>Clinocera</i> / <i>Trichoclinocera</i>	Empididae	Diptera	0.19%	0.50
<i>Dixidae</i> sp.	Dixidae	Diptera	0.19%	0.50
Heptageniidae	Heptageniidae	Ephemeroptera	0.19%	0.50
Physidae	Physidae	Pulmonata	0.19%	0.50
Empididae	Empididae	Diptera	0.10%	0.25
Heptageniidae	Heptageniidae	Ephemeroptera	0.10%	0.25
Collenette sp.	Collenette sp.	Collembola	0.10%	0.25
Hydropsychidae	Hydropsychidae	Trichoptera	0.10%	0.25
Elmidae	Elmidae	Coleoptera	0.10%	0.25
Nematoidea sp.	Nematoidea sp.	Nematoda sp.	0.10%	0.25
Plecoptera sp.	Plecoptera sp.	Plecoptera	0.10%	0.25
Simuliidae	Simuliidae	Diptera	0.10%	0.25

site - PO08 date - 9/19/2001
Jordan Park Mill Creek, Bonny Slope

taxa	family	order	relative abundances	densities (# / ft ²)
Orthocladiinae	Chironomidae	Diptera	19.09%	88.32
<i>Simulium</i>	Simuliidae	Diptera	17.31%	80.09
<i>Cheumatopsyche</i>	Hydropsychidae	Trichoptera	15.86%	73.35
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	14.72%	68.11
Tanytarsini	Chironomidae	Diptera	14.24%	65.87
Chironomidae sp.	Chironomidae	Diptera	3.72%	17.22
Tanypodinae	Chironomidae	Diptera	2.91%	13.47
Chironomidae sp. Pupae	Chironomidae	Diptera	2.10%	9.73
Ancylidae / Lynnaeidae sp.	Ancylidae / Lynnaeidae	Pulmonata	1.78%	8.23
<i>Chelifera</i>	Empididae	Diptera	1.62%	7.49
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	1.46%	6.74
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	1.29%	5.99
Nematoda sp.	Nematoda sp.	Nematoda sp.	0.97%	4.49
Simuliidae sp.	Simuliidae	Diptera	0.81%	3.74
Chironomini	Chironomidae	Diptera	0.65%	2.99
Trichoptera sp.	Trichoptera sp.	Trichoptera	0.49%	2.25
<i>Juga</i>	Lymnaeidae	Pulmonata	0.32%	1.50
Heptageniidae sp.	Heptageniidae	Ephemeroptera	0.16%	0.75
Psychodidae	Psychodidae	Diptera	0.16%	0.75
Sialidae	Sialidae	Megaloptera	0.16%	0.75
Turbellaria sp.	Turbellaria sp.	Turbellaria sp.	0.16%	0.75

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - PO10
date - 10/3/2001
riffle

Balch Creek / Audubon Sanctuary

Balch Creek, Willamette Heights

taxa	family	order	relative abundances	densities (# / ft ²)	
Juga	Pleuroceridae	Prosobranchia	23.93%	92.07	
Ironodes	Heptageniidae	Ephemeroptera	12.45%	47.90	
Paraleptophlebia	Lepioptebiliidae	Ephemeroptera	7.20%	27.69	
Heptageniidae sp.	Heptageniidae	Ephemeroptera	6.61%	25.45	
Rhyacophilidae	Rhyacophilidae	Trichoptera	6.42%	24.70	
Sweltsa	Chloroperlidae	Plecoptera	5.06%	19.46	
Hydropsyche	Hydropsychidae	Trichoptera	4.88%	18.71	
Pseudocloeon	Baetidae	Ephemeroptera	3.31%	12.72	
Tanytarsini	Chironomidae	Diptera	3.31%	12.72	
Maruma	Psychodidae	Diptera	2.53%	9.73	
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	2.53%	9.73	
Baetidae sp.	Heptageniidae	Ephemeroptera	2.14%	8.23	
Cingma	Dixidae	Ephemeroptera	2.14%	8.23	
Dixa	Glossosomatidae	Diptera	1.56%	5.99	
Glossosoma	Hydracarina sp.	Trichoptera	1.56%	5.99	
Hydracarina sp.	Lepidostomatidae	Hydracarina sp.	1.56%	5.99	
Lepidostoma	Nemouridae	Trichoptera	1.56%	5.99	
Nemouridae sp.	Copepoda sp.	Plecoptera	1.56%	5.99	
Copepoda sp.	Chironomidae	Copepoda sp.	1.36%	5.24	
Chironomidae sp.	Collembola sp.	Diptera	0.97%	3.74	
Collembola sp.	Ephemeroplera sp.	Collembola	0.97%	3.74	
Ephemeroplera sp.	Heterlimnius	Ephemeroptera	0.58%	2.25	
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae	Coleoptera	0.58%	2.25	
Elmidae sp.	Elmidae	Corbiculacea	0.58%	2.25	
Lara	Elmidae	Coleoptera	0.39%	1.50	
Orthocladiinae	Chironomidae	Diptera	0.39%	1.50	
Psychoptera	Psychopteridae	Diptera	0.39%	1.50	
					total 384.73

taxa	family	order	relative abundances	densities (# / ft ²)
Juga	Pleuroceridae	Prosobranchia	23.93%	92.07
Ironodes	Heptageniidae	Ephemeroptera	12.45%	47.90
Paraleptophlebia	Lepioptebiliidae	Ephemeroptera	7.20%	27.69
Heptageniidae sp.	Heptageniidae	Ephemeroptera	6.61%	25.45
Rhyacophilidae	Rhyacophilidae	Trichoptera	6.42%	24.70
Sweltsa	Chloroperlidae	Plecoptera	5.06%	19.46
Hydropsyche	Hydropsychidae	Trichoptera	4.88%	18.71
Pseudocloeon	Baetidae	Ephemeroptera	3.31%	12.72
Tanytarsini	Chironomidae	Diptera	3.31%	12.72
Maruma	Psychodidae	Diptera	2.53%	9.73
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	2.53%	9.73
Baetidae sp.	Heptageniidae	Ephemeroptera	2.14%	8.23
Cingma	Dixidae	Ephemeroptera	2.14%	8.23
Dixa	Glossosomatidae	Diptera	1.56%	5.99
Glossosoma	Hydracarina sp.	Trichoptera	1.56%	5.99
Hydracarina sp.	Lepidostomatidae	Hydracarina sp.	1.56%	5.99
Lepidostoma	Nemouridae	Trichoptera	1.56%	5.99
Nemouridae sp.	Copepoda sp.	Plecoptera	1.56%	5.99
Copepoda sp.	Chironomidae	Copepoda sp.	1.36%	5.24
Chironomidae sp.	Collembola sp.	Diptera	0.97%	3.74
Collembola sp.	Ephemeroplera sp.	Collembola	0.97%	3.74
Ephemeroplera sp.	Heterlimnius	Ephemeroptera	0.58%	2.25
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae	Coleoptera	0.58%	2.25
Elmidae sp.	Elmidae	Corbiculacea	0.58%	2.25
Lara	Elmidae	Coleoptera	0.39%	1.50
Orthocladiinae	Chironomidae	Diptera	0.39%	1.50
Psychoptera	Psychopteridae	Diptera	0.39%	1.50
				total

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - PO11
date - 10/22/2001
riffle

Balch Creek / Lower Macleay Park
Balch Creek / Willamette Highlands

taxa	family	order	relative abundances	densities (# / ft ²)
<i>Cinygma</i>	Heptageniidae	Ephemeroptera	15.50%	61.38
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	10.40%	41.17
<i>Juga</i>	Pleuroceridae	Prosobranchia	9.26%	36.68
<i>Zapada</i>	Nemouridae	Plecoptera	7.31%	29.19
<i>Isonodes</i>	Heptageniidae	Ephemeroptera	6.98%	27.89
Basellidae sp.	Baetidae	Ephemeroptera	5.10%	20.21
Heptageniidae sp.	Heptageniidae	Ephemeroptera	4.16%	16.47
<i>Marina</i>	Psychodidae	Diptera	4.16%	16.47
Orthocladiinae	Chironomidae	Diptera	3.97%	15.72
Pseudocloeon	Baetidae	Ephemeroptera	3.40%	13.47
Copepoda sp.	Copepoda sp.	Copepoda sp.	2.84%	11.23
<i>Rhyacophila</i>	Rhyacophilidae	Trichoptera	2.84%	11.23
<i>Glossosomatidae</i>	Glossosomatidae	Trichoptera	2.65%	10.48
<i>Lepidophlebiidae</i>	Lepidophlebiidae	Ephemeroptera	2.48%	9.73
Elmidae	Elmidae	Coleoptera	2.27%	8.98
<i>Paraleptophlebia</i>	Chironomidae	Coleoptera	1.70%	6.74
Elmidae sp.	Simuliidae	Diptera	1.32%	5.24
<i>Opifexfusca</i>	Chironomidae	Diptera	1.32%	5.24
Tanytarsini	Chironomidae	Diptera	1.13%	4.49
<i>Simulium</i>	Elmidae	Coleoptera	1.13%	4.49
Tanypodinae	Nematoidea sp.	Nematoidea sp.	1.13%	4.49
Chironomidae sp.	Chironomidae	Diptera	0.78%	2.99
<i>Heterinthus</i>	Collembola sp.	Collembola	0.78%	2.99
Nematoidea sp.	Hydracarina sp.	Hydracarina sp.	0.75%	2.99
Chironomidae sp. Pupae	Trichoptera sp.	Trichoptera	0.75%	2.99
Collembola sp.	Elmidae	Coleoptera	0.57%	2.25
Hydracarina sp.	Ephemeroptera sp.	Ephemeroptera	0.38%	1.50
Trichoptera sp. Pupae	Polycentropodidae	Trichoptera	0.38%	1.50
<i>Ampulvis</i>	Amphipoda sp.	Amphipoda	0.19%	0.75
Ephemeroptera sp.				
<i>Polycentropodus</i>				
Amphipoda sp.				
				total 395.96

taxa	family	order	relative abundances	densities (# / ft ²)
<i>Anisochela</i>	Tipulidae	Diptera	0.19%	0.75
<i>Chelifer</i>	Empididae	Diptera	0.19%	0.75
Chironomini	Chironomidae	Diptera	0.19%	0.75
<i>Dicranota</i>	Tipulidae	Diptera	0.19%	0.75
<i>Dixa</i>	Dixidae	Diptera	0.19%	0.75
<i>Hydropsyche</i>	Hydropsychidae	Trichoptera	0.19%	0.75
<i>Narpus</i>	Elmidae	Coleoptera	0.19%	0.75
<i>Plecoptera</i> sp.	Plecoptera	Plecoptera	0.19%	0.75
<i>Nemouridae</i>	Nemouridae	Plecoptera	0.19%	0.75
<i>Sphaeriidae / Corbiculidae</i>	Sphaeriidae / Corbiculidae	Corticulacea	0.19%	0.75
<i>Chloroperlidae</i>	Chloroperlidae	Plecoptera	0.19%	0.75
<i>Tipulidae</i>	Tipulidae	Diptera	0.19%	0.75
<i>Turbellaria</i> sp.	Turbellaria sp.	Turbellaria sp.	0.19%	0.75
<i>Veliidae</i>	Veliidae	Hemiptera	0.19%	0.75
				total 395.96

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - P012
date - 10/3/2001
rifile

Saltzman / Forest Park New Site
Willbridge

taxa	family	order	relative abundances	densities (# / #12)	family	order	relative abundances	densities (# / #12)
Zapada	Nemouridae	Plecoptera	19.97%	51.43	Hydropsychidae	Trichoptera	0.73%	1.88
Juga	Pleuroceridae	Prosobranchia	7.58%	19.52	Polycentropodidae	Trichoptera	0.58%	1.50
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	5.83%	15.02	Sminthuridae	Collembola	0.58%	1.50
Scydida	Nemouridae	Plecoptera	5.39%	13.89	Trichoptera sp.	Trichoptera	0.58%	1.50
Rhyacophilida	Rhyacophilidae	Trichoptera	4.96%	12.76	Chironomidae sp. Pupae	Diptera	0.44%	1.13
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	4.37%	11.26	Hexatomidae	Diptera	0.44%	1.13
Orthocladiinae	Chironomidae	Diptera	4.37%	11.26	Simuliidae	Diptera	0.44%	1.13
Nemouridae sp.	Nemouridae	Plecoptera	3.06%	7.88	Caenaria	Plecoptera	0.29%	0.75
Swallow	Chloroperidae	Plecoptera	3.06%	7.88	Empididae	Diptera	0.29%	0.75
Cinygma	Heptageniidae	Ephemeroptera	2.92%	7.51	Leuctridae	Plecoptera	0.29%	0.75
Dixa	Dixidae	Diptera	2.92%	7.51	Baetidae	Ephemeroptera	0.29%	0.75
Lepidostomatida	Lepidostomatidae	Trichoptera	2.92%	7.51	Nematoda sp.	Nematoda sp.	0.29%	0.75
Paraleptophlebia	Lepidophlebiidae	Ephemeroptera	2.77%	7.13	Simuliidae sp.	Diptera	0.29%	0.75
Baetidae sp.	Baetidae	Ephemeroptera	2.48%	6.38	Elmidae	Coleoptera	0.29%	0.75
Glossosoma	Glossosomatidae	Trichoptera	2.48%	6.38	Elmidae	Coleoptera	0.29%	0.75
Copepoda sp.	Copepoda sp.	Copepoda sp.	1.75%	4.50	Tipulidae	Diptera	0.15%	0.38
Collembola sp.	Collembola sp.	Collembola	1.60%	4.13	Ceratopogonidae	Diptera	0.15%	0.38
Pseudocloeon	Baetidae	Ephemeroptera	1.60%	4.13	Glossosomatidae sp. Pupae	Trichoptera	0.15%	0.38
Maruina	Psychodidae	Diptera	1.46%	3.75	Helophorus	Coleoptera	0.15%	0.38
Itronodes	Heptageniidae	Ephemeroptera	1.31%	3.38	Hydraenidae	Coleoptera	0.15%	0.38
Tanypodinae	Chironomidae	Diptera	1.17%	3.00	Hydropsychidae	Trichoptera	0.15%	0.38
Tanytarsini	Chironomidae	Diptera	1.02%	2.63	Dixidae	Diptera	0.15%	0.38
Wormadida	Philopotamidae	Trichoptera	1.02%	2.63	Sialidae	Megaloptera	0.15%	0.38
Chloroperlidae sp.	Chloroperlidae	Plecoptera	0.87%	2.25	Sphaeromias	Diptera	0.15%	0.38
Cinygma	Heptageniidae	Ephemeroptera	0.87%	2.25	Thaumaleidae	Diptera	0.15%	0.38
Elmidae sp.	Elmidae	Coleoptera	0.87%	2.25	Trichoptera sp.	Trichoptera	0.15%	0.38
Gluiops	Pelecynchidae	Diptera	0.87%	2.25	Turbellaria sp.	Turbellaria sp.	0.15%	0.38
Heptageniidae sp.	Heptageniidae	Ephemeroptera	0.87%	2.25	Peltoperlidae	Plecoptera	0.15%	0.38
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae	Corbiculacea	0.87%	2.25				
Chironomidae sp.	Chironomidae	Diptera	0.73%	1.88				
								total
								257.51

Appendix II. Relative abundances and densities of all invertebrate taxa (all sites).

site - PR01
date - 9/18/2001
glide

site - SH02
date - 9/6/2001
glide

taxa	family	order	relative abundances	densities (# / ft2)	
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	34.48%	135.48	
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae	Corbiculacea	21.14%	83.08	
Chironomidae	Chironomidae	Diptera	18.67%	73.35	
Hydrobiidae	Hydrobiidae	Prosobranchia	7.05%	27.69	
Tanypodidae	Tanypodidae	Diptera	4.38%	17.22	
Corbicula	Corbicula	Corbiculacea	2.48%	9.73	
Gammarus	Gammaridae	Amphipoda	1.71%	6.74	
Copepoda sp.	Copepoda sp.	Copepoda sp.	1.14%	4.49	
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	1.14%	4.49	
Ostracoda sp.	Ostracoda sp.	Ostracoda sp.	1.14%	4.49	
Chironomidae sp.	Chironomidae	Diptera	0.95%	3.74	
Orthocladiinae	Chironomidae	Diptera	0.95%	3.74	
Probaeza	Ceratopogonidae	Diptera	0.95%	3.74	
Chironomidae sp. Pupae	Chironomidae	Diptera	0.76%	2.99	
Lymnaeidae sp.	Lymnaeidae	Pulmonata	0.57%	2.25	
Sialis	Sialidae	Megaloptera	0.57%	2.25	
Ceratopogonidae sp.	Ceratopogonidae	Diptera	0.38%	1.50	
Nemaloda sp.	Nemaloda	Nemaloda sp.	0.38%	1.50	
Cladocera sp.	Cladocera sp.	Cladocera sp.	0.19%	0.75	
Collembola sp.	Collembola sp.	Collembola	0.19%	0.75	
Sminthuridae sp.	Sminthuridae	Collembola	0.19%	0.75	
Tanytarsini	Chironomidae	Diptera	0.19%	0.75	
Unionidae sp.	Unionidae	Unionacea	0.19%	0.75	
Zygoptera sp.	Zygoptera sp.	Odonata	0.19%	0.75	
		total		392.96	

Public Park
Cedar Creek, Sherwood

relative abundances

densities (# / ft2)

taxa	family	order	relative abundances	densities (# / ft2)	
Oligochaeta sp.	Oligochaeta sp.	Cladocera sp.	46.00%	1526.52	
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae	Copepoda sp.	15.64%	518.94	
Chironomidae	Chironomidae	Chironomidae	12.10%	401.52	
Hydrobiidae	Hydrobiidae	Chironomidae	11.30%	375.00	
Tanypodidae	Tanypodidae	Oligochaeta sp.	4.91%	162.38	
Corbicula	Corbicula	Ceratopogonidae	2.63%	87.12	
Gammarus	Gammaridae	Sphaeridae / Corbiculidae	2.05%	68.18	
Copepoda sp.	Copepoda sp.	Chironomidae	1.71%	56.82	
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	1.03%	34.09	
Ostracoda sp.	Ostracoda sp.	Physidae	0.80%	26.52	
Chironomidae sp.	Chironomidae	Isopoda sp.	0.68%	22.73	
Orthocladiinae	Chironomidae	Hydrobiidae	0.34%	11.36	
Probæza	Ceratopogonidae	Sialidae	0.34%	11.36	
Chironomidae sp. Pupae	Chironomidae	Conixidae	0.11%	3.79	
Lymnaeidae sp.	Lymnaeidae	Diptera sp. Pupae	0.11%	3.79	
Sialis	Sialidae	Dixellidae	0.11%	3.79	
Ceratopogonidae sp.	Ceratopogonidae	Nematoda sp.	0.11%	3.79	
Nemaloda sp.	Nemaloda				
Cladocera sp.	Cladocera sp.				
Collembola sp.	Collembola sp.				
Sminthuridae sp.	Sminthuridae				
Tanytarsini	Chironomidae				
Unionidae sp.	Unionidae				
Zygoptera sp.	Zygoptera sp.				
		total		392.96	

relative abundances

densities (# / ft2)

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - T101
date - 9/5/2001
glide

site - T102
date - 9/18/2001
glide

taxa	family	order	relative abundances	densities (# / ft ²)
Sphaeriidae / Corbiculidae sp.	Sphaeriidae / Corbiculidae	Corbiculidae	41.87%	393.86
Oligochaeta sp.	Oligochaeta sp.	Oligochaetae	16.87%	156.72
Ostracoda sp.	Ostracoda sp.	Ostracoda	14.29%	134.33
Tanytropidinae	Chironomidae	Chironomidae	6.55%	61.57
Cladocera sp.	Cladocera sp.	Cladocera	5.75%	54.10
Chironomidae	Chironomidae	Chironomidae	3.37%	31.72
Physidae sp.	Pulmonata	Pulmonata	3.37%	31.72
Copepoda sp.	Copepoda sp.	Copepoda	2.58%	24.25
Planorbidae sp.	Planorbidae	Planorbidae	1.39%	13.06
Lymnaeidae sp.	Pulmonata	Pulmonata	1.19%	11.19
Gammaeridae	Amphipoda	Amphipoda	0.60%	5.80
Sialis	Megaloptera	Megaloptera	0.60%	5.80
Hydracarina sp.	Hydracarina sp.	Hydracarina	0.40%	3.73
Orthocladiinae	Chironomidae	Chironomidae	0.40%	3.73
Amphipoda sp.	Amphipoda sp.	Amphipoda	0.20%	1.87
Diptera sp. Pupae	Diptera sp.	Diptera	0.20%	1.87
Dixa	Dixidae	Dixidae	0.20%	1.87
Juga	Pleuroceridae	Pleuroceridae	0.20%	1.87
Nematoidea sp.	Nematoidea sp.	Nematoidea	0.20%	1.87
total				940.30

taxa	family	order	relative abundances	densities (# / ft ²)
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta	57.98%	114.49
Hydrobiidae sp.	Hydrobiidae	Hydrobiidae	8.94%	17.64
Chironomini	Chironomidae	Chironomidae	4.18%	8.26
Corbicula	Corbiculidae	Corbiculidae	3.99%	7.88
Tanytropidinae	Tanytropidinae	Tanytropidinae	3.99%	7.88
Orthocladiinae	Orthocladiinae	Orthocladiinae	3.80%	7.51
Gammarellus	Gammarellidae	Gammarellidae	3.04%	6.01
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae	Sphaeridae / Corbiculidae	2.66%	5.26
Chironomidae sp. Pupae	Chironomidae	Chironomidae	2.17%	3.38
Pseudocloeon	Baetidae	Baetidae	1.52%	3.00
Chironomidae sp.	Chironomidae	Chironomidae	1.33%	2.63
Tanystarsiini	Tanystarsiini	Tanystarsiini	1.33%	2.63
Juga	Prosbobranchia	Prosbobranchia	1.14%	2.25
Hydropsychidae	Hydropsychidae	Hydropsychidae	0.95%	1.88
Hydracarina sp.	Hydracarina sp.	Hydracarina	0.76%	1.50
Nematoidea sp.	Nematoidea sp.	Nematoidea	0.57%	1.13
Amphipoda sp.	Amphipoda sp.	Amphipoda	0.38%	0.75
Copepoda sp.	Copepoda sp.	Copepoda	0.38%	0.75
Lymnaeidae	Lymnaeidae	Lymnaeidae	0.38%	0.75
Collembola sp.	Collembola sp.	Collembola	0.19%	0.38
Diptera sp. Pupae	Diptera sp.	Diptera	0.19%	0.38
Isopoda sp.	Isopoda sp.	Isopoda	0.19%	0.38
Lara	Eriidae	Eriidae	0.19%	0.38
Ostracoda sp.	Ostracoda sp.	Ostracoda	0.19%	0.38
total				197.45

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - T104
date - 9/6/2001
glide

Lowery Open Space / Woodard Park
Fanno Creek, Tigard

taxa	family	order	relative abundances	densities (# / 12)
Hydrobiidae sp.	Hydrobiidae	Prostobranchia	26.67%	32.88
Juga	Pleuroceridae	Prostobranchia	12.68%	15.63
Gammareus	Gammaridae	Amphipoda	11.16%	13.75
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta	10.34%	12.75
Tanytarsini	Chironomidae	Diptera	8.42%	10.38
Cladocera sp.	Cladocera sp.	Cla docera	5.38%	6.63
Tanypodinae	Chironomidae	Diptera	5.07%	6.25
Corbicula	Corbiculidae	Corbiculacea	2.84%	3.50
Lymnaeidae sp.	Lymnaeidae	Pulmonata	2.03%	2.50
Chironomini	Chironomidae	Diptera	1.93%	2.38
Pseudocloeon	Baetidae	Ephemeroptera	1.72%	2.13
Chironomidae sp. Pupae	Chironomidae	Diptera	1.52%	1.88
Hydropsyche	Hydropsychidae	Trichoptera	1.52%	1.88
Copepoda sp.	Copepoda sp.	Copepoda	1.32%	1.63
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae	Corbiculacea	1.22%	1.50
Chironomidae sp.	Chironomidae	Diptera	1.12%	1.38
Orthocladinae	Chironomidae	Diptera	1.01%	1.25
Cheumatopsyche	Hydropsychidae	Trichoptera	0.91%	1.13
Hydracarina sp.	Hydracarina sp.	Hydracarina	0.91%	1.13
Amphipoda sp.	Amphipoda sp.	Amphipoda	0.71%	0.88
Sialis	Sialidae	Megaloptera	0.51%	0.63
Nematoda sp.	Nematoda sp.	Nematoda	0.41%	0.50
Hydropsyche sp.	Hydropsyche	Trichoptera	0.20%	0.25
Probezzia	Ceratopogonidae	Diptera	0.20%	0.25
Astacidae / Cambaridae sp.	Astacidae / Cambaridae	Decapoda	0.10%	0.13
Isopoda sp.	Isopoda sp.	Isopoda	0.10%	0.13
		total		123.25

Windsor Place / Black Bull Park /
Englewood Park
Fanno Creek, Tigard

site - T105
date - 9/10/2001
glide

taxa	family	order	relative abundances	densities (# / ft2)
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta	40.71%	73.20
Juga	Sphaeridae / Corbiculidae	Prostobranchia	28.60%	51.43
Gammareus	Tanypodinae	Corbiculacea	12.73%	22.90
Oligochaeta sp.	Hydrobiidae sp.	Diptera	5.01%	9.01
Tanytarsini	Chironomidae	Prostobranchia	4.18%	7.51
Cladocera sp.	Hydrobiidae	Diptera	2.51%	4.50
Tanypodinae	Chironomidae	Diptera	1.67%	3.00
Corbicula	Ceratopogonidae	Hydracarina	1.67%	3.00
Lymnaeidae sp.	Hydracarina sp.	Copepoda	0.84%	1.50
Chironomini	Copepoda sp.	Diptera	0.84%	1.50
Pseudocloeon	Orthocladinae	Decapoda	0.21%	0.38
Chironomidae sp. Pupae	Astacidae / Cambaridae sp.	Diptera	0.21%	0.38
Hydropsyche	Ceratopogonidae	Chironomidae	0.21%	0.38
Copepoda sp.	Copepoda sp.	Gerridae	0.21%	0.38
Sphaeridae / Corbiculidae sp.	Corbiculacea	Isopoda	0.21%	0.38
Chironomidae sp.	Diptera	Stalidae	0.21%	0.38
Orthocladinae	Diptera	Megaloptera	0.21%	0.38
Cheumatopsyche	Hydropsychidae	total		179.80
Hydracarina sp.	Hydracarina sp.			
Amphipoda sp.	Amphipoda			
Sialis	Megaloptera			
Nematoda sp.	Nematoda			
Hydropsyche sp.	Trichoptera			
Probezzia	Diptera			
Astacidae / Cambaridae sp.	Decapoda			
Isopoda sp.	Isopoda			

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - T106
date - 9/21/2001
rifile
Tigard

site - T107
date - 9/20/2001
glide

taxa	family	order	relative abundances	densities (# / ft ²)	
<i>Juga</i>	Pleuroceridae	Prosbanchia	37.69%	24.98	
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	12.69%	8.38	Oligochaeta sp.
Orthocladinae	Chironomidae	Diptera	12.69%	8.38	Corbiculidae
Tanytarsini	Chironomidae	Diptera	11.55%	7.63	Chironomidae
<i>Simulium</i>	Simuliidae	Diptera	7.95%	5.25	Hydrobidae
Chironomidae sp.	Chironomidae	Diptera	6.08%	4.00	Sphaenidae / Corbiculidae
Tanypodinae	Chironomidae	Diptera	4.17%	2.75	Gammarellidae
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	1.70%	1.13	Ceratopogonidae
Amphipoda sp.	Amphipoda	Amphipoda	1.33%	0.88	Chironomidae
Gammarus	Gammaridae	Amphipoda	1.14%	0.75	Tanytarsini
<i>Dicranota</i>	Tipulidae	Diptera	0.57%	0.38	Chironomidae sp. Pupae
Chironomidae sp. Pupae	Chironomidae	Diptera	0.38%	0.25	Turbellaria sp.
Collenettea sp.	Collenetteidae	Collembola	0.38%	0.25	Cladocera sp.
Hydrophilidae	Hydrophilidae	Coleoptera	0.38%	0.25	Coenagrionidae
Rhyacophilidae	Rhyacophilidae	Trichoptera	0.38%	0.25	Orthocladiinae
Baetidae	Baetidae	Ephemeroptera	0.19%	0.13	Ostracoda sp.
Chironomidae	Chironomidae	Diptera	0.19%	0.13	Copepoda sp.
<i>Hyalelia</i>	Hyalellidae	Amphipoda	0.19%	0.13	Hydracarina sp.
Isopoda sp.	Isopoda sp.	Isopoda sp.	0.19%	0.13	Juga
Tipulidae sp.	Tipulidae	Diptera	0.19%	0.13	Planorbiidae
				total	66.00

taxa	family	order	relative abundances	densities (# / ft ²)	
<i>Juga</i>	Pleuroceridae	Prosbanchia	37.69%	24.98	Oligochaeta sp.
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	12.69%	8.38	Corbiculidae
Orthocladinae	Chironomidae	Diptera	12.69%	8.38	Chironomidae
Tanytarsini	Chironomidae	Diptera	11.55%	7.63	Hydrobidae
<i>Simulium</i>	Simuliidae	Diptera	7.95%	5.25	Sphaenidae / Corbiculidae
Chironomidae sp.	Chironomidae	Diptera	6.08%	4.00	Gammarellidae
Tanypodinae	Chironomidae	Diptera	4.17%	2.75	Ceratopogonidae
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	1.70%	1.13	Chironomidae
Amphipoda sp.	Amphipoda	Amphipoda	1.33%	0.88	Tanytarsini
Gammarus	Gammaridae	Amphipoda	1.14%	0.75	Chironomidae
<i>Dicranota</i>	Tipulidae	Diptera	0.57%	0.38	Chironomidae
Chironomidae sp. Pupae	Chironomidae	Diptera	0.38%	0.25	Turbellaria sp.
Collenettea sp.	Collenetteidae	Collembola	0.38%	0.25	Cladocera sp.
Hydrophilidae	Hydrophilidae	Coleoptera	0.38%	0.25	Coenagrionidae
Rhyacophilidae	Rhyacophilidae	Trichoptera	0.38%	0.25	Orthocladiinae
Baetidae	Baetidae	Ephemeroptera	0.19%	0.13	Ostracoda sp.
Chironomidae	Chironomidae	Diptera	0.19%	0.13	Copepoda sp.
<i>Hyalelia</i>	Hyalellidae	Amphipoda	0.19%	0.13	Hydracarina sp.
Isopoda sp.	Isopoda sp.	Isopoda sp.	0.19%	0.13	Pleuroceridae
Tipulidae sp.	Tipulidae	Diptera	0.19%	0.13	Planorbiidae
				total	66.00
					Total
					393.71

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - T108
date - 9/20/2001
glide

Oxbow Park near Sandy River
Gordon Creek, Troutdale

site - TR01
date - 10/2/2001
rifile

taxa	family	order	relative abundances	densities (# / ft2)	taxa	family	order	relative abundances	densities (# / ft2)
Oligochaeta sp.	Oligochaetae sp.	Oligochaeta sp.	46.13%	31.25	Pseudocloeon	Baetidae	Ephemeroptera	18.11%	92.07
Gammaurus	Gammaridae	Amphipoda	19.93%	13.50	Antocha	Tripidae	Diptera	10.90%	55.39
Tanyopodinae	Chironomidae	Diptera	7.93%	5.38	Zapada	Nemouridae	Plecoptera	6.63%	33.68
Orthocadiinae	Chironomidae	Diptera	5.90%	4.00	Hydropsyche	Hydropsychidae	Trichoptera	6.33%	32.19
Amphipoda sp.	Amphipoda sp.	Amphipoda	4.98%	3.38	Epeorus	Heptageniidae	Ephemeroptera	6.04%	30.69
Tanytarsini	Chironomidae	Diptera	4.24%	2.88	Paraleptophlebia	Leptophlebiidae	Ephemeroptera	5.89%	29.94
Prodeomesinae	Chironomidae	Diptera	3.14%	2.13	Rhithrogena	Heptageniidae	Ephemeroptera	5.01%	25.45
Chironomini	Chironomidae	Diptera	2.21%	1.50	Orthocladiinae	Chironomidae	Diptera	4.86%	24.70
Copepoda sp.	Copepoda sp.	Copepoda sp.	1.11%	0.75	Glossosoma	Glossosomatidae	Trichoptera	4.71%	23.95
Chironomidae	Chironomidae	Diptera	0.92%	0.63	Rhyacophilidae	Rhyacophilidae	Trichoptera	4.27%	21.71
Nemouridae	Nemouridae	Plecoptera	0.55%	0.38	Elmidae	Elmidae	Coleoptera	3.39%	17.22
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae sp.	Corbiculacea	0.55%	0.38	Heptageniidae	Heptageniidae	Ephemeroptera	2.95%	14.97
Nematoda sp.	Nematoda sp.	Nematoda sp.	0.37%	0.25	Baetidae	Baetidae	Ephemeroptera	2.50%	12.72
Simuliidum	Simuliidae	Diptera	0.37%	0.25	Ephemeraliidae	Ephemeraliidae	Ephemeroptera	2.50%	12.72
Cyclorrhaphous Diptera sp. Larvae	Diptera sp.	Diptera sp.	0.18%	0.13	Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	2.36%	11.98
Diptera sp.	Diptera sp.	Diptera	0.18%	0.13	Chironomidae	Chironomidae	Diptera	2.21%	11.23
Dixa	Dixidae	Diptera	0.18%	0.13	Chironomidae	Chironomidae	Diptera	2.06%	10.48
Gerridae sp.	Gerridae	Hemiptera	0.18%	0.13	Simuliidae	Simuliidae	Diptera	1.47%	7.49
Lepidostoma	Lepidostomatidae	Trichoptera	0.18%	0.13	Calineuria	Perilidae	Plecoptera	1.33%	6.74
Lymnaeidae sp.	Lymnaeidae	Pulmonata	0.18%	0.13	Periodidae	Periodidae	Plecoptera	1.18%	5.99
Sminthuridae sp.	Sminthuridae	Collembola	0.18%	0.13	Trichoptera sp.	Trichoptera	0.88%	4.49	
Tipulidae sp.	Tipulidae	Diptera	0.18%	0.13	Hydracarina sp.	Hydracarina sp.	Diptera	0.74%	3.74
Turbellaria sp.	Turbellaria sp.	Turbellaria sp.	0.18%	0.13	Elmidae	Elmidae	Plecoptera	0.44%	2.25
Ianiodes	Ianiodes	Plecoptera sp.	0.18%	0.13	Simuliidae	Simuliidae	Plecoptera	0.44%	2.25
Simuliidae sp. Pupae	Zelitzeva	Turbellaria sp.	0.18%	0.13	Chloroperlidae	Chloroperlidae	Plecoptera	0.44%	2.25
Collembola sp.	Collembola sp.	Turbellaria sp.	0.18%	0.13	Turbellaria sp.	Turbellaria sp.	Diptera	0.44%	2.25
Despaxia	Despaxia	Turbellaria sp.	0.18%	0.13	Heptageniidae	Heptageniidae	Ephemeroptera	0.29%	1.50
Drunella	Drunella	Turbellaria sp.	0.18%	0.13	Elmidae	Elmidae	Diptera	0.29%	1.50
Ephemeroptera sp.	Ephemeroptera sp.	Turbellaria sp.	0.18%	0.13	Collembola sp.	Collembola	Collembola	0.15%	0.75
Micrasma	Micrasma	Turbellaria sp.	0.18%	0.13	Leuctridae	Leuctridae	Plecoptera	0.15%	0.75
Probazia	Probazia	Turbellaria sp.	0.18%	0.13	Ephemeraliidae	Ephemeraliidae	Ephemeroptera	0.15%	0.75
Wormialia	Wormialia	Turbellaria sp.	0.18%	0.13	Ephemeroptera sp.	Ephemeroptera sp.	Trichoptera	0.15%	0.75
				total	67.75				total

taxa	family	order	relative abundances	densities (# / ft2)	taxa	family	order	relative abundances	densities (# / ft2)
Pseudocloeon	Baetidae	Ephemeroptera	18.11%	92.07	Antocha	Tripidae	Diptera	10.90%	55.39
Antocha	Tripidae	Plecoptera	6.63%	33.68	Zapada	Nemouridae	Trichoptera	6.33%	32.19
Zapada	Nemouridae	Hydropsychidae	6.33%	32.19	Hydropsyche	Hydropsychidae	Trichoptera	6.33%	32.19
Hydropsyche	Hydropsychidae	Ephemeroptera	6.04%	30.69	Epeorus	Heptageniidae	Ephemeroptera	6.04%	30.69
Epeorus	Heptageniidae	Leptophlebiidae	5.89%	29.94	Paraleptophlebia	Leptophlebiidae	Ephemeroptera	5.89%	29.94
Paraleptophlebia	Leptophlebiidae	Heptageniidae	5.01%	25.45	Rhithrogena	Heptageniidae	Ephemeroptera	5.01%	25.45
Rhithrogena	Heptageniidae	Orthocladiinae	4.86%	24.70	Orthocladiinae	Glossosomatidae	Trichoptera	4.86%	24.70
Orthocladiinae	Glossosomatidae	Glossosoma	4.71%	23.95	Glossosoma	Rhyacophilidae	Trichoptera	4.71%	23.95
Glossosoma	Rhyacophilidae	Rhyacophilidae	4.27%	21.71	Rhyacophilidae	Elmidae	Trichoptera	4.27%	21.71
Rhyacophilidae	Elmidae	Elmidae	3.39%	17.22	Elmidae	Heptageniidae	Ephemeroptera	3.39%	17.22
Elmidae	Heptageniidae	Heptageniidae	2.95%	14.97	Heptageniidae	Baetidae	Ephemeroptera	2.95%	14.97
Heptageniidae	Baetidae	Baetidae	2.50%	12.72	Baetidae	Ephemeraliidae	Ephemeroptera	2.50%	12.72
Baetidae	Ephemeraliidae	Ephemeraliidae	2.36%	12.72	Ephemeraliidae	Oligochaeta sp.	Oligochaeta sp.	2.36%	12.72
Ephemeraliidae	Oligochaeta sp.	Oligochaeta sp.	2.21%	11.98	Oligochaeta sp.	Chironomidae	Diptera	2.21%	11.98
Oligochaeta sp.	Chironomidae	Chironomidae	2.06%	11.23	Chironomidae	Chironomidae	Diptera	2.06%	11.23
Chironomidae	Chironomidae	Simuliidae	1.47%	7.49	Simuliidae	Perilidae	Plecoptera	1.47%	7.49
Simuliidae	Perilidae	Calineuria	1.33%	6.74	Calineuria	Periodidae	Plecoptera	1.33%	6.74
Calineuria	Periodidae	Periodidae	1.18%	5.99	Periodidae	Trichoptera	Plecoptera	1.18%	5.99
Periodidae	Trichoptera	Trichoptera	0.88%	4.49	Trichoptera	Hydracarina sp.	Diptera	0.88%	4.49
Trichoptera	Hydracarina sp.	Hydracarina sp.	0.74%	3.74	Hydracarina sp.	Elmidae	Plecoptera	0.74%	3.74
Hydracarina sp.	Elmidae	Elmidae	0.44%	2.25	Elmidae	Simuliidae	Plecoptera	0.44%	2.25
Elmidae	Simuliidae	Simuliidae	0.44%	2.25	Simuliidae	Chloroperlidae	Plecoptera	0.44%	2.25
Simuliidae	Chloroperlidae	Chloroperlidae	0.44%	2.25	Chloroperlidae	Turbellaria sp.	Diptera	0.44%	2.25
Chloroperlidae	Turbellaria sp.	Turbellaria sp.	0.44%	2.25	Turbellaria sp.	Ephemeroptera	Plecoptera	0.44%	2.25
Ephemeroptera	Plecoptera	Plecoptera	0.29%	1.50	Plecoptera	Diptera	Plecoptera	0.29%	1.50
Diptera	Plecoptera	Plecoptera	0.29%	1.50	Diptera	Collembola	Collembola	0.29%	1.50
Collembola	Collembola	Collembola	0.15%	0.75	Collembola	Leuctridae	Plecoptera	0.15%	0.75
Leuctridae	Leuctridae	Leuctridae	0.15%	0.75	Leuctridae	Ephemeraliidae	Ephemeroptera	0.15%	0.75
Ephemeraliidae	Ephemeraliidae	Ephemeraliidae	0.15%	0.75	Ephemeraliidae	Ephemeroptera	Ephemeroptera	0.15%	0.75
Ephemeroptera	Ephemeroptera	Ephemeroptera	0.15%	0.75	Ephemeroptera	Brachyceridae	Ephemeroptera	0.15%	0.75
Brachyceridae	Brachyceridae	Brachyceridae	0.15%	0.75	Brachyceridae	Ceratopogonidae	Ephemeroptera	0.15%	0.75
Ceratopogonidae	Ceratopogonidae	Ceratopogonidae	0.15%	0.75	Ceratopogonidae	Philopotamidae	Ephemeroptera	0.15%	0.75
Philopotamidae	Philopotamidae	Philopotamidae	0.15%	0.75	Philopotamidae	Wormialia	Ephemeroptera	0.15%	0.75
Wormialia	Wormialia	Wormialia	0.15%	0.75	Wormialia	total	total	0.15%	0.75

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - WI01
date - 9/17/2001
glide

New Parks (Private - enter on Valahos Dr)
Beckman Creek, Wilsonville

site - WI02
date - 9/17/2001
riffle

taxa	family	order	relative abundances	densities (# / ft ²)
Sphaeriidae / Corbiculidae sp.	Sphaeriidae / Corbiculidae	Corbiculidae	43.65%	292.86
Tanytarsini	Chironomidae	Diptera	18.55%	124.25
Oligochaeta sp.	Oligochaeta sp.	Diptera	9.50%	63.62
Chironomini	Chironomidae	Diptera	7.37%	49.40
Tanypodinae	Hydracarina sp.	Diptera	4.36%	29.19
Hydracarina sp.	Hydracarina sp.	Diptera	3.35%	22.46
Orthocladiinae	Chironomidae	Diptera	2.35%	15.72
Chironomidae sp. Pupae	Chironomidae	Diptera	2.01%	13.47
Chironomidae sp.	Chironomidae	Diptera	1.79%	11.98
Copepoda sp.	Copepoda sp.	Copepoda sp.	1.68%	11.23
Juga	Pleuroceridae	Diptera	1.45%	9.73
Lepidostoma	Lepidostomatidae	Trichoptera	1.34%	8.98
Cladocera sp.	Cladocera sp.	Cladocera sp.	0.89%	5.99
Hydrobiidae	Hydrobiidae	Prosobranchia	0.22%	1.50
Lara	Elmidae	Coleoptera	0.22%	1.50
Lymnaeidae sp.	Lymnaeidae	Pulmonata	0.22%	1.50
Proboscia	Ceratopogonidae	Diptera	0.22%	1.50
Dixa	Dixidae	Diptera	0.11%	0.75
Dixella	Dixidae	Diptera	0.11%	0.75
Forcipomyia	Ceratopogonidae	Diptera	0.11%	0.75
Hemerodromia	Empididae	Diptera	0.11%	0.75
Nematoidea sp.	Nematoidea sp.	Nematoda sp.	0.11%	0.75
Opilioservus	Elmidae	Colleptera	0.11%	0.75
Stilis	Stilidae	Megaloptera	0.11%	0.75
		Total		669.91

Memorial Park
Beckman Creek, Wilsonville

taxa	family	order	relative abundances	densities (# / ft ²)
Sphaeriidae / Corbiculidae sp.	Sphaeriidae / Corbiculidae	Corbiculidae	37.62%	45.38
Juga	Juga	Prosobranchia	30.88%	37.25
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	13.89%	16.75
Chironomini	Chironomidae	Trichoptera	2.69%	3.25
Tanypodinae	Tanypodinae	Diptera	2.28%	2.75
Hydracarina sp.	Pseudocloeon	Ephemeroptera	2.18%	2.63
Orthocladiinae	Orthocladiinae	Diptera	2.07%	2.50
Hemerodromia	Hemerodromia	Diptera	1.35%	1.63
Hydrobiidae	Hydrobiidae	Prosobranchia	1.24%	1.50
Anzydidae / Lymnaeidae sp.	Ancylidae / Lymnaeidae	Pulmonata	1.14%	1.38
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	1.04%	1.25
Nematoidea sp.	Nematoidea sp.	Nematoda sp.	0.73%	0.88
Chironomini	Chironomidae	Diptera	0.52%	0.63
Chironomidae	Chironomidae	Trichoptera	0.41%	0.50
Dicranota	Tipulidae	Diptera	0.41%	0.50
Simulium	Simuliidae	Diptera	0.41%	0.50
Hexatomata	Tipulidae	Diptera	0.31%	0.38
Hydropsychidae sp.	Hydropsychidae	Trichoptera	0.31%	0.38
Chironomidae sp. Pupae	Chironomidae	Diptera	0.21%	0.25
Empididae sp.	Empididae	Diptera	0.10%	0.13
Gammarus	Gammaridae	Amphipoda	0.10%	0.13
Stilis	Stilidae	Megaloptera	0.10%	0.13
		Total		120.63

Appendix IV (cont.): Relative abundances and densities of all invertebrate taxa

site - WL01
date - 9/10/2001

Palomino Park / Hidden Springs Open Space
West Linn

site • WL02 date - 9/10/2001
client
Renaissance Open Space / Sahallie •
Illahhee Park Impact / Inc

taxa	family	order	relative abundances	densities (# / ft ²)
Tanytarsinii	Chironomidae	Diptera	20.47%	78.59
Tanytardinae	Chironomidae	Diptera	16.37%	62.87
Sphaeridae / Corbiculidae sp.	Sphaeridae / Corbiculidae	Corbiculacea	15.20%	58.38
Oligochaeta sp.	Oligochaeta sp.	Oligochaeta sp.	10.72%	41.17
Prodeamesinae	Chironomidae	Diptera	6.82%	26.20
Hydracarina sp.	Hydracarina sp.	Hydracarina sp.	6.63%	25.45
Chironomidae	Chironomidae	Diptera	4.87%	18.71
Chironomidae	Planorbidiae	Diptera	4.68%	17.96
Chironomidae	Chironomidae	Pulmonata	4.48%	17.22
Chironomidae	Chironomidae	Diptera	1.95%	7.49
Isopoda sp.	Isopoda sp.	Isopoda sp.	1.95%	7.49
Nematoidea sp.	Nematoidea sp.	Nematoda sp.	1.17%	4.49
Rhyacophilidae	Rhyacophilidae	Trichoptera	0.97%	3.74
Chironomidae	Chironomidae	Diptera	0.58%	2.25
Hydrophilidae	Hydrophilidae	Coleoptera	0.58%	2.25
Empididae	Empididae	Diptera	0.39%	1.50
Hydrobiidae	Hydrobiidae	Prostbranchia	0.39%	1.50
Baetidae	Baetidae	Ephemeroptera	0.39%	1.50
Collenetteidae	Collenetteidae	Collembola	0.19%	0.75
Hydrobiidae sp.	Hydrobiidae sp.	Copepoda sp.	0.19%	0.75
Pseudocloeon	Pseudocloeon	Tipulidae	0.19%	0.75
Caenidae	Caenidae	Limnephilidae	0.19%	0.75
Turbellaria sp.	Turbellaria sp.	Simuliidae	0.19%	0.75
Psychoglypha	Psychoglypha	Sciomyzidae	0.19%	0.75
Silvulaeidae sp.	Silvulaeidae sp.	Tetanocera	0.19%	0.75
Turbellaria sp.	Turbellaria sp.	Turbellaria sp.	0.19%	0.75

Renaissance Open Space / Sahaliie -
Illahee Park
West / iron

taxa	family	order	relative abundances	densities (# / ft ²)	
<i>Juga</i>	Pleuroceridae	Prostibranchia	22.84%	15.50	
	Oligochaeta sp.	Oligochaeta sp.	21.55%	14.63	
	Chironomidae	Diptera	16.21%	11.00	
	Sphaeritidae / Corbiculidae	Corticulacea	9.02%	6.13	
	Amphipoda sp.	Amphipoda	7.92%	5.38	
	Chironomidae	Diptera	3.87%	2.63	
	Chironomidae	Diptera	3.87%	2.63	
	Chironomidae	Diptera	3.68%	2.50	
	Chironomidae	Diptera	2.58%	1.75	
	Baetidae	Ephemeroptera	1.10%	0.75	
	Rhyacophilidae	Trichoptera	1.10%	0.75	
	Chironomidae	Diptera	0.92%	0.63	
	Syrnidae	Diptera	0.92%	0.63	
	Chironomidae	Diptera	0.92%	0.63	
	Nemouridae	Plecoptera	0.55%	0.38	
	Collembola sp.	Collembola	0.37%	0.25	
	Dicranota	Diptera	0.37%	0.25	
	Tipulidae	Trichoptera	0.37%	0.25	
	Limnephilidae	Collembola	0.37%	0.25	
	Sminthuridae	Collembola	0.37%	0.25	
	Psephenidae	Coleoptera	0.18%	0.13	
	Empididae	Diptera	0.18%	0.13	
	Hydrobiidae	Prostibranchia	0.18%	0.13	
	Lymnaeidae	Pulmonata	0.18%	0.13	
	Nematoda sp.	Nematoda sp.	0.18%	0.13	
	Hydropsycheidae	Trichoptera	0.18%	0.13	
	Tipulidae	Diptera	0.18%	0.13	
	Thaumaleidae	Diptera	0.18%	0.13	
					total
					67.88

Appendix V: Relative abundances and densities for all Ephemeroptera, Plecoptera, and Trichoptera taxa (all sites)

site - AL01		Hazeldale Park / Rosa Park Butternut Creek, Aloha			
taxa	family	order	relative abundances	densities (# / ft2)	
Lepidostoma	Lepidostomatidae	Trichoptera	0.18%	0.75	
	totals		0.18%	0.75	
site - AL02		Meadowbrook Park / Stoddard Park / Butternut Creek Elementary School Butternut Creek, Aloha			
taxa	family	order	relative abundances	densities (# / ft2)	
Caloptilia	Baetidae	Ephemeroptera	0.41%	2.99	
	totals		0.41%	2.99	
site - AL03		Aloha / Pheasant Park Beaverton Creek, Aloha			
taxa	family	order	relative abundances	densities (# / ft2)	
none	none	none	0.00%	0	
	totals		0.00%	0	
site - AL06		Carlton Homeowners Aloha			
taxa	family	order	relative abundances	densities (# / ft2)	
Ephemeroptera sp.	Ephemeroptera sp.	Ephemeroptera	0.09%	0.75	
Lepidostoma	Lepidostomatidae	Trichoptera	0.09%	0.75	
Limnephilidae sp.	Limnephilidae	Trichoptera	0.09%	0.75	
	totals		0.26%	2.25	

site - BE01		Murrayhill Homeowners Summer Creek, Cooper Mountain			
date - 9/25/2001 riffle					
taxa	family	order	relative abundances	densities (# / ft2)	
Pseudocloeon	Baetidae	Ephemeroptera	17.28%	8.25	
Cingirma	Heptageniidae	Ephemeroptera	9.42%	4.50	
Rhyacophilidae	Rhyacophilidae	Trichoptera	2.36%	1.13	
Heptageniidae sp.	Heptageniidae	Ephemeroptera	1.05%	0.50	
Hydropsychidae sp.	Hydropsychidae	Trichoptera	0.26%	0.13	
Limnephilidae sp. Pupae	Limnephilidae	Trichoptera	0.26%	0.13	
Trichoptera sp.	Trichoptera sp.	Trichoptera	0.26%	0.13	
Trichoptera sp. Pupae	Trichoptera sp.	Trichoptera	0.26%	0.13	
	totals		31.15%	14.88	
site - BE02		Stonemist Park / Cain Park / Sumnercrest Park			
date - 9/4/2001 glide		Johnson Creek, Beaverton			
taxa	family	order	relative abundances	densities (# / ft2)	
none	none	none	0.00%	0	
	totals		0.00%	0	
site - BE03		Public Utility / Hunters Woods HOA Willow Creek, Cedar Mill			
date - 9/12/2001 glide					
taxa	family	order	relative abundances	densities (# / ft2)	
none	none	none	0.00%	0	
	totals		0.00%	0	

Appendix V (cont.): Relative abundances and densities for all Ephemeroptera, Plecoptera, and Trichoptera taxa (all sites)

site - BE04 date - 9/25/2001 glide		Tualatin Hills Nature Park Cedar Johnson Creek, Beaverton		Heather Park Dev. Co. <i>Corneliaus</i>	
taxa		family		order	
				relative abundances	
				densities (# / fl2)	densities (# / fl2)
none	none	none	none	0.00%	0
					0
		totals		0.00%	0

site - DU01 date - 9/20/2001 glide		Durham City Park <i>Fanno Creek, Durham</i>		Heather Park Dev. Co. <i>Corneliaus</i>	
taxa		family		order	
				relative abundances	
				densities (# / fl2)	densities (# / fl2)
		Hydropsychidae	Hydropsychidae	Trichoptera	0.32%
		<i>Cheumatopsyche</i> sp.	<i>Cheumatopsyche</i>	Trichoptera	0.16%
		Baetidae	Hydropsychidae		0.75
		Baetidae	Hydropsychidae		0.38
		Pseudocloeon			
		totals		totals	0.48% 1.13

site - GR01 date - 8/31/2001 glide		Kane Road Neighborhood Park <i>Kelly Creek, Gresham</i>		Heather Park Dev. Co. <i>Corneliaus</i>	
taxa		family		order	
				relative abundances	
				densities (# / fl2)	densities (# / fl2)
		<i>Psychoglypha</i>	Limnephilidae	Trichoptera	0.16%
		Psychoglypha	Limnephilidae		3.79
		totals		totals	0.16% 3.79

site - BO01 date - 8/28/2001 glide		Springwater Corridor North Fork Deep Creek, Boring		Heather Park Dev. Co. <i>Corneliaus</i>	
taxa		family		order	
				relative abundances	
				densities (# / fl2)	densities (# / fl2)
		Ephemeroptera	21.50		
		Trichoptera	0.25		
		Ephemeroptera	0.05%	0.25	
		Trichoptera	0.05%	0.13	
		Trichoptera	0.05%	0.13	
		totals	8.15%	22.25	

Appendix V (cont.): Relative abundances and densities for all Ephemeroptera, Plecoptera, and Trichoptera taxa (all sites)

site - GR02 date - 8/27/2001 rifflle		Main City Park / Gresham Pioneer Cemetery / Springwater Corridor Johnson Creek, Gresham			
taxa	family	order	relative abundances	densities (# / ft2)	
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	9.48%	18.75	
<i>Paraleptophlebia</i>	Leptophlebiidae	Ephemeroptera	9.46%	18.75	
<i>Hydropsychidae</i> sp.	Hydropsychidae	Trichoptera	0.38%	0.75	
<i>Hydropsyche</i>	Hydropsycheidae	Trichoptera	0.38%	0.75	
<i>Cinygma</i>	Heptageniidae	Ephemeroptera	0.13%	0.25	
<i>Hydropsyche</i> sp. Pupae	Hydropsycheidae	Trichoptera	0.13%	0.25	
	totals		19.92%	39.50	

site - GR04 date - 8/31/2001 rifflle		Butler Creek Open Space Jenne Creek, Gresham			
taxa	family	order	relative abundances	densities (# / ft2)	
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	0.48%	1.13	
<i>Paraleptophlebia</i>	Ephemeroptera sp.	Ephemeroptera	0.32%	0.75	
<i>Hydropsychidae</i> sp.	Baetidae	Ephemeroptera	0.16%	0.38	
<i>Hydropsyche</i>	Leptophlebiidae	Ephemeroptera	0.16%	0.38	
<i>Paraleptophlebia</i>					
	totals		1.11%	2.83	

site - GR05 date - 9/3/2001 rifflle		Springwater Corridor Johnson Creek, Gresham			
taxa	family	order	relative abundances	densities (# / ft2)	
<i>Cheumatopsyche</i>	Hydropsychidae	Trichoptera	18.76%	46.55	
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	15.73%	35.04	
<i>Paraleptophlebia</i>	Leptophlebiidae	Ephemeroptera	2.42%	6.01	
	totals		36.91%	91.59	

site - GR06 date - 9/3/2001 rifflle		North of Butler Creek site Jenne Creek, Gresham			
taxa	family	order	relative abundances	densities (# / ft2)	
<i>Cheumatopsyche</i>	Hydropsychidae	Trichoptera	19.50%	25.25	
<i>Paraleptophlebia</i>	Leptophlebiidae	Ephemeroptera	15.39%	20.63	
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	4.05%	5.25	
<i>Glossosoma</i>	Glossosomatidae	Trichoptera	0.19%	0.25	
<i>Lepidostomatidae</i>	Lepidostomatidae	Trichoptera	0.19%	0.25	
<i>Trichoptera</i> sp. Pupae	Trichoptera sp.	Trichoptera	0.19%	0.25	
<i>Diplectrona</i>	Baetidae	Ephemeroptera	0.10%	0.13	
	totals		40.15%	52.00	

site - GR07 date - 9/3/2001 rifflle		Springwater Corridor Johnson Creek, Gresham			
taxa	family	order	relative abundances	densities (# / ft2)	
<i>Cheumatopsyche</i>	Hydropsychidae	Trichoptera	2.19%	7.51	
<i>Baetidae</i> sp.	Baetidae	Ephemeroptera	0.11%	0.38	
	totals		2.30%	7.88	

Appendix V (cont.): Relative abundances and densities for all Ephemeroptera, Plecoptera, and Trichoptera taxa (all sites)

site - HB02 date - 9/6/2001 glide		Bethany Lake Park Rock Creek, Bethany		Honeywood Park / Chantal Village Park / Arleda Park / Willow Creek West Beaverton Creek, Aloha			
taxa	family	order	relative abundances	densities (# / ft2)	order	relative abundances	densities (# / ft2)
none	none	none	0.00%	0	none	0.00%	0
	totals		0.00%	0	totals	0.00%	0

site - HB03 date - 9/24/2001 glide		Rock Creek Greenway Rock Creek, Merle		Hamby Park / Jackson School North Hillsboro			
taxa	family	order	relative abundances	densities (# / ft2)	order	relative abundances	densities (# / ft2)
none	none	none	0.00%	0	none	0.00%	0
	totals		0.00%	0	totals	0.00%	0

site - HB04 date - 9/13/2001 glide		Willow Creek Nature Park / Mushofsky Park Stonegate Phase II Park Willow Creek, Marlene Village		Bethany Meadows Park / Springville Meadows Park Ben Graf Meadows Park Bethany			
taxa	family	order	relative abundances	densities (# / ft2)	order	relative abundances	densities (# / ft2)
none	none	none	0.00%	0	Lepidostoma	0.32%	1.50
	totals		0.00%	0	Leptophlebiidae	0.32%	1.50

site - HB05 date - 10/3/2001 glide		Orenco Woods Golf Course Rock Creek, Merle		Notifer Property / Upper Rock Creek Open Space Rock Creek, Marie			
taxa	family	order	relative abundances	densities (# / ft2)	order	relative abundances	densities (# / ft2)
Ephemeroptera sp.	Ephemeroptera sp.	Ephemeroptera	0.20%	0.54	Leptophlebiidae sp.	0.57%	0.75
		totals	0.20%	0.54	totals	0.57%	0.75

Appendix V (cont.): Relative abundances and densities for all Ephemeroptera, Plecoptera, and Trichoptera taxa (all sites)

site - HB11 date - 9/13/2001 glide		site - L001 date - 10/2/2001 glide		site - Bryant Woods Park (Private) Lake Oswego	
site - HB12 date - 9/25/2001 glide		site - MCCR date - 10/1/2001 glide		site - McKay Creek Reference Site McKay Creek, Shadybrook	
site - HB13 date - 9/25/2001 glide					
taxa	family	order	relative abundances	densities (# / ft2)	densities (# / ft2)
none	none	none	0.00%	0	0
	totals		0.00%	0	0
site - HB11 date - 9/13/2001 glide	Salix Park Willow Creek, Elmmonica				
taxa	family	order	relative abundances	densities (# / ft2)	densities (# / ft2)
none	none	none	0.00%	0	0
	totals		0.00%	0	0
site - HB12 date - 9/25/2001 glide	Deerfield Park Bethany				
taxa	family	order	relative abundances	densities (# / ft2)	densities (# / ft2)
none	none	none	0.00%	0	0
	totals		0.00%	0	0
site - HB13 date - 9/25/2001 glide	Middle Rock Cr. Open Space / Dawson Cr. Properties / Creekside Rock Creek, Oregon				
taxa	family	order	relative abundances	densities (# / ft2)	densities (# / ft2)
none	none	none	0.00%	0	0
	totals		0.00%	0	0
site - HB14 date - 8/30/2001 glide	Valley Memorial Park Cemetery Rock Creek, Newton				
taxa	family	order	relative abundances	densities (# / ft2)	densities (# / ft2)
Mystacidae	Lepidoceridae	Trichoptera	0.20%	0.75	0.75
	totals		0.20%	0.75	0.75
				totals	29.45% 26.25

Appendix V (cont.): Relative abundances and densities for all Ephemeroptera, Plecoptera, and Trichoptera taxa (all sites)

site - M101 date - 8/24/2001 riffle		North Clackamas Central Park Kellogg Creek, Milwaukie			
taxa	family	order	relative abundances	densities (# / ft2)	
<i>Cheumatopsyche</i>	Hydropsychidae	Trichoptera	9.43%	35.93	
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	2.95%	11.23	
<i>Hydropsyche</i>	Hydropsychidae	Trichoptera	0.39%	1.50	
<i>Hydropsyche</i>	Hydropsycheidae	Trichoptera	0.39%	1.50	
<i>Lepidostoma</i>	Leptostomatidae	Trichoptera	0.39%	1.50	
		totals		13.56%	51.65
site - P001 date - 8/28/2001 riffle		Marshall Park Tryon Creek, Englewood / Lake Oswego			
taxa	family	order	relative abundances	densities (# / ft2)	
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	21.67%	11.38	
<i>Hydropsyche</i>	Hydropsychidae	Trichoptera	0.71%	0.38	
<i>Hydropsyche</i> sp. Pupae	Hydropsycheidae	Trichoptera	0.24%	0.13	
<i>Psychoglypha</i>	Limnephilidae	Trichoptera	0.24%	0.13	
		totals		22.86%	12.00

site - P002 date - 10/1/2001 riffle		Tryon Creek State Park South Tryon Creek, Englewood / Lake Oswego			
taxa	family	order	relative abundances	densities (# / ft2)	
<i>Hydropsyche</i>	Hydropsychidae	Hydropsychidae		14.12%	13.38
	Paraleptophlebia	Leptophlebiidae		10.29%	9.75
	<i>Cinygma</i>	Heptageniidae		3.56%	3.38
	<i>Pseudocloeon</i>	Baetidae		3.17%	3.00
	<i>Baetidae</i>	Baetidae		1.58%	1.50
	<i>Heptageniidae</i>	Heptageniidae		0.92%	0.88
	<i>Nemouridae</i> sp.	Nemouridae		0.26%	0.25
	<i>Ephemeroplera</i> sp.	Ephemeroplera		0.13%	0.13
	<i>Limnephilidae</i>	Limnephilidae		0.13%	0.13
	<i>Rhyacophilidae</i>	Rhyacophilidae		0.13%	0.13
	<i>Trichoptera</i> sp.	Trichoptera		0.13%	0.13
		totals		34.43%	32.63
site - P008 date - 9/19/2001 riffle		Jordan Park Mill Creek, Bonny Slope			
taxa	family	order	relative abundances	densities (# / ft2)	
<i>Chewratopsyche</i>	Hydropsychidae	Hydropsychidae		15.86%	73.35
	<i>Pseudocloeon</i>	Baetidae		14.72%	68.11
	<i>Trichoptera</i> sp.	Trichoptera		0.49%	2.25
	<i>Heptageniidae</i> sp.	Heptageniidae		0.16%	0.75
		totals		31.23%	144.46
site - P003 date - 10/1/2001 riffle		Tryon Creek State Park North Tryon Creek, Englewood / Lake Oswego			
taxa	family	order	relative abundances	densities (# / ft2)	
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	27.31%	70.25	
<i>Hydropsyche</i>	Hydropsychidae	Trichoptera	7.97%	20.50	
<i>Paraleptophlebia</i>	Leptophlebiidae	Ephemeroptera	0.97%	2.50	
<i>Heptageniidae</i> sp.	Heptageniidae	Ephemeroptera	0.19%	0.50	
<i>Cinygma</i>	Heptageniidae	Ephemeroptera	0.10%	0.25	
<i>Hydropsychidae</i> sp.	Hydropsychidae	Trichoptera	0.10%	0.25	
<i>Plecoptera</i> sp.	Plecoptera	Plecoptera	0.10%	0.25	
		totals		36.73%	94.50

Appendix V (cont.): Relative abundances and densities for all Ephemeroptera, Plecoptera, and Trichoptera taxa (all sites)

site - PO10 date - 10/3/2001 riffle	Balch Creek / Audubon Sanctuary Balch Creek, Willamette Heights	family	order	relative abundances	densities (# / ft2)
<i>Isonodes</i>	Heptageniidae	Ephemeroptera	12.45%	47.90	
<i>Paraleptophlebia</i>	Leptophlebiidae	Ephemeroptera	7.20%	27.69	
<i>Heptageniidae</i> sp.	Heptageniidae	Ephemeroptera	6.61%	25.45	
<i>Rhyacophila</i>	Rhyacophilidae	Trichoptera	6.42%	24.70	
<i>Sweilsea</i>	Chironartiidae	Plecoptera	5.06%	19.46	
<i>Hydropsyche</i>	Hydropsychidae	Trichoptera	4.86%	18.71	
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	3.31%	12.72	
<i>Baetidae</i> sp.	Baetidae	Ephemeroptera	2.14%	8.23	
<i>Cinygma</i>	Heptageniidae	Ephemeroptera	2.14%	8.23	
<i>Glossosoma</i>	Glossosomatidae	Leptophlebiidae			
<i>Lepidostoma</i>	Lepidostomatidae	Trichoptera sp.	1.56%	5.99	
<i>Nemouridae</i> sp.	Nemouridae	Trichoptera	1.56%	5.99	
<i>Ephemeroptera</i> sp.	Ephemeroptera sp.	Plecoptera	1.56%	5.99	
<i>Chloroperlidae</i> sp.	Chloroperlidae	Ephemeroptera	0.58%	2.25	
<i>Nemouridae</i> sp.	Nemouridae	Plecoptera	0.19%	0.75	
<i>Soyedina</i>	Nemouridae	Plecoptera	0.19%	0.75	
<i>Penitidae</i> / <i>Perlodidae</i> sp.	Penitidae / Perlodidae	Plecoptera	0.19%	0.75	
<i>Wormaldia</i>	Philopotamidae	Trichoptera	0.19%	0.75	
		totals		56.42%	217.07

site - PO11 date - 10/2/2001 riffle	Balch Creek / Lower Macleay Park Balch Creek / Willamette Heights	taxa	family	order	relative abundances	densities (# / ft2)
<i>Isonodes</i>	Heptageniidae	Heptageniidae	Ephemeroptera	15.50%	61.38	
<i>Zapada</i>	Nemouridae	Plecoptera	7.37%	29.19		
<i>Isonodes</i>	Heptageniidae	Ephemeroptera	6.99%	27.69		
<i>Baetidae</i> sp.	Baetidae	Ephemeroptera	5.10%	20.21		
<i>Heptageniidae</i> sp.	Heptageniidae	Ephemeroptera	4.16%	16.47		
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	3.40%	13.47		
<i>Rhyacophila</i>	Rhyacophilidae	Trichoptera	2.84%	11.23		
<i>Glossosoma</i>	Glossosomatidae	Trichoptera	2.65%	10.48		
<i>Paraleptophlebia</i>	Leptophlebiidae	Ephemeroptera	2.46%	9.73		
<i>Cinygma</i>	Trichoptera sp.	Trichoptera	0.76%	2.99		
<i>Glossosoma</i>	Ephemeroptera sp.	Ephemeroptera	0.38%	1.50		
<i>Lepidostoma</i>	Polycentropodidae	Trichoptera	0.38%	1.50		
<i>Nemouridae</i> sp.	Chloroperlidae	Plecoptera	0.19%	0.75		
<i>Ephemeroptera</i> sp.	Hydropsychidae	Trichoptera	0.19%	0.75		
<i>Chloroperlidae</i> sp.	Nemouridae	Plecoptera	0.19%	0.75		
<i>Nemouridae</i> sp.	Soyedina	Plecoptera sp.	0.19%	0.75		
<i>Soyedina</i>	Plecoptera sp.	Plecoptera	0.19%	0.75		
<i>Penitidae</i> / <i>Perlodidae</i> sp.						
<i>Wormaldia</i>						
		totals		52.74%	208.83	

Appendix V (cont.): Relative abundances and densities for all Ephemeroptera, Plecoptera, and Trichoptera taxa (all sites)

taxa riffle	family	order	relative abundances	densities (#/ ft2)				
<i>Zapada</i>	Nemouridae	Plecoptera	19.97%	51.43				
<i>Sovedina</i>	Nemouridae	Plecoptera	5.39%	13.89				
<i>Rhyacophilidae</i>	Rhyacophilidae	Trichoptera	4.96%	12.76				
<i>Sweitsa</i>	Chloroperlidae	Plecoptera	3.06%	7.88				
<i>Nemouridae sp.</i>	Nemouridae	Plecoptera	3.06%	7.88				
<i>Cinygma</i>	Haplogenilidae	Ephemeroptera	2.92%	7.51				
<i>Lepidostoma</i>	Lepidostomidae	Trichoptera	2.92%	7.51				
<i>Paraleptophlebia</i>	Leptophlebiidae	Ephemeroptera	2.77%	7.13				
<i>Baetidae sp.</i>	Baetidae	Ephemeroptera	2.48%	6.38				
<i>Glossosomatidae</i>	Glossosomatidae	Trichoptera	2.48%	6.38				
<i>Pseudocloeon</i>	Baetidae	Ephemeroptera	1.60%	4.13				
<i>Isonychia</i>	Haplogenilidae	Ephemeroptera	1.31%	3.38				
<i>Wormaldia</i>	Philopotamidae	Trichoptera	1.02%	2.63				
<i>Chloroperlidae sp.</i>	Chloroperlidae	Plecoptera	0.87%	2.25				
<i>Cinygma</i>	Haplogenilidae	Ephemeroptera	0.87%	2.25				
<i>Haplogeniidae sp.</i>	Haplogeniidae	Ephemeroptera	0.87%	2.25				
<i>Parapsyche</i>	Hydropsychidae	Trichoptera	0.73%	1.88				
<i>Polycentropus</i>	Polycentropodidae	Trichoptera	0.58%	1.50				
<i>Trichoptera sp. Pupae</i>	Trichoptera sp.	Trichoptera	0.58%	1.50				
<i>Diphetor</i>	Baetidae	Ephemeroptera	0.29%	0.75				
<i>Despaxia</i>	Leuctridae	Plecoptera	0.29%	0.75				
<i>Calineuria</i>	Perilidae	Plecoptera	0.29%	0.75				
<i>Glossosomatidae sp. Pupae</i>	Glossosomatidae	Trichoptera	0.15%	0.38				
<i>Hydropsyche</i>	Hydropsychidae	Trichoptera	0.15%	0.38				
<i>Yoraperia</i>	Peltoperlidae	Plecoptera	0.15%	0.38				
<i>Trichoptera sp.</i>	Trichoptera	Trichoptera	0.15%	0.38				
		totals	59.91%	154.28				

taxa riffle	family	order	relative abundances	densities (#/ ft2)				
		none	none	0				
		none	none	0				
		none	none	0				
		totals	0.00%	0				

taxa	family	order	relative abundances	densities (#/ ft2)				
		none	none	0				
		none	none	0				
		totals	0.00%	0				

Appendix V (cont.): Relative abundances and densities for all Ephemeroptera, Plecoptera, and Trichoptera taxa (all sites)

site - T104		Lowery Open Space / Woodard Park		Greenvale Park	
date - 9/6/2001		Fanno Creek, Tigard		Fanno Creek, Tigard	
glide					
taxa	family	order	relative abundances	densities (# / ft ²)	densities (# / 112)
<i>Pseudocleoson</i>	Baetidae	Ephemeroptera	1.72%	2.13	0
<i>Hydropsilia</i>	Hydropsychidae	Trichoptera	1.52%	1.88	
<i>Cheumatopsyche</i>	Hydropsychidae	Trichoptera	0.91%	1.13	
<i>Hydropsychidae</i> sp.	Hydropsychidae	Trichoptera	0.20%	0.25	
				totals	0.00%

site - TI08	Windsor Place / Black Bull Park / Englewood Park	Copper Creek Greenway
date - 9/10/2001	Fanno Creek, Tigard	Copper Creek, Tigard
glide		
totals	4.36%	5.38

site - TI06	Creekside Park / Holly Tree Terrace Trails /	order	relative abundances	densities (# / 12)
date - 9/21/2001	Genesis # 3			
riffle	Tigard			
Taxa	family			
<i>Rhyacophilidae</i>	<i>Rhyacophilidae</i>	Trichoptera	0.38%	0.25
<i>Baetidae</i>	<i>Baetidae</i>	Ephemeroptera	0.19%	0.13
		totals	0.57%	0.38

site - T107		Greenway Park Fanno Creek, Tigard		relative abundances		densities (# / 12)
taxa	family	order		none	0.00%	0
glide				none	0.00%	0
				totals	0.00%	0

taxa	family	order	relative abundances	densities (# / 12)
Soyedina	Nemouridae	Plecoptera	0.55%	0.38
Lepidostoma	Lepidostomatidae	Trichoptera	0.18%	0.13
		totals	0.74%	0.50